United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

IN REPLY REFER TO:
1-1-98-F-62

March 12, 1999

Ms. Alexis Strauss
Acting Director, Water Division
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

Lt. Colonel Peter Grass
District Engineer
U.S. Army Corps of Engineers
333 Market Street
San Francisco, California 94105

Subject: Programmatic Formal Endangered Species Consultation on the Proposed Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region, California

Dear Ms. Strauss and Lt. Col. Grass:

This document transmits the U.S. Fish and Wildlife Service's (Service) programmatic biological opinion based on the Service's review of the proposed Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (LTMS), California, and its effects on the endangered salt marsh harvest mouse (*Reithrodontomys raviventris*) (harvest mouse), endangered California clapper rail (*Rallus longirostris obsoletus*) (clapper rail), endangered California least tern (*Sterna antillarum browni*) (least tern), endangered California brown pelican (*Pelecanus occidentalis*) (pelican), threatened coastal population of the western snowy plover (*Charadrius alexandrinus nivosus*) (plover), threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat, and threatened Sacramento splittail (*Pogonichthys macrolepidotus*) (splittail) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). The U.S. Environmental Protection Agency's (EPA) February 18, 1998, request for formal consultation was received on February 23, 1998.

This biological opinion is based on information provided in: (1) the January 1998, *Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region, 2nd Administrative Final, Policy EIS/Programmatic EIR* (EIS/EIR)(3 vols.); (2) the *Characteristics of California Least Tern Nesting Sites Associated With Breeding Success or Failure, With Special Reference to the Site at the Naval Air Station, Alameda* report prepared by Dr. Carolee Caffrey and dated August 26, 1995 (Caffrey report); (3) the Golden Gate Audubon Society's March 12, 1994, *A Scientific Symposium: Alameda Naval Air Station's Natural Resources and Base Closure* (Symposium Proceedings); (4) numerous meetings between the

Service, National Marine Fisheries Service (NMFS), and EPA; and (5) additional information contained in Service files. A complete administrative record of this consultation is on file in this office.

This formal endangered species consultation covers actions authorized by the LTMS agencies, which include the EPA, San Francisco District U.S. Army Corps of Engineers (Corps), San Francisco Bay Conservation and Development Commission (BCDC), California State Water Resources Control Board (SWRCB), and San Francisco Bay Regional Water Quality Control Board (SFRWQCB). Actions proposed by the LTMS agencies that meet the conditions specified below, or that the Service determines will have similar effects, may be appended to this programmatic consultation. The geographic scope of this consultation includes diked and tidal wetlands within the San Francisco Bay Estuary downstream from the confluence of the Sacramento and San Joaquin Rivers west of Sherman Island.

The purpose of this programmatic consultation is to expedite LTMS projects with relatively small effects on listed and proposed species and critical habitat. The Corps and EPA may request separate review under the Act for those projects which can not meet the requirements specified below or which exceed the programmatic threshold. The Service will re-evaluate this programmatic consultation annually to ensure that its continued application will not result in unacceptable effects on listed and proposed species and critical habitats.

**Programmatic Consultation Guidelines**

Proposed projects that will receive consideration for inclusion under this programmatic consultation must meet the following criteria:

1. The projects must be reviewed and processed via the Dredged Materials Management Office, which is comprised of representatives of the LTMS agencies.

2. Any adverse effects on listed and proposed species and their habitats resulting from the proposed project must be minor, as determined by the Service.

3. Any new upland and wetland disposal or reuse site(s) for dredged materials must be authorized to accept dredged materials through separate review under the Act.

**Implementing Procedure**

The LTMS agencies and Service will implement the following procedures when evaluating proposed dredging and dredged material disposal projects relative to this programmatic consultation :

1. Federal and non-Federal project proponents or the LTMS agencies will request a species list from the Service to determine whether any listed and proposed species and critical

habitat occurs in the vicinity of the project site. To obtain a species list, applicants may submit a written or verbal request to the Service's Section 7 Biological Technician and provide a short project name, the name of the USGS 7.5 minute quadrangle(s) on which the project occurs, and a return address. Requests can be submitted in writing to the Service's Section 7 Biological Technician at 3310 El Camino Avenue, Suite 130, Sacramento, CA 95821, or by calling (916) 979-2753. The Service typically responds to requests for Species Lists within a few days of when they are received.

2. If any listed and proposed species and critical habitat are present in the vicinity of the proposed project site, the Corps will determine whether the proposed project may affect those species or destroy or adversely modify any critical habitat. If the Corps determines that the proposed project is not likely to adversely affect any listed and proposed species and is not likely to destroy or adversely modify any critical habitat, then the Corps will submit to the Service a written request for the Service's concurrence. If the Corps determines that the proposed project is likely to adversely affect any listed and proposed species and critical habitats, then the Corps will submit to the Service a request to append the proposed project to this programmatic biological opinion or will request separate endangered species consultation. The Service requires approximately 30 days to review and respond to these requests. For each project that may affect listed and proposed species and critical habitat, the Corps will submit information to the Service that adequately describes the proposed project, any species that may be affected, and the nature of the potential effects, as required under Part 402.14 (c) and (d) of the regulations governing interagency cooperation (51 **FR** 19957). Any proposed minimization measures should be incorporated into the project description.

3. The Service will review the proposed project and any proposed additional permit conditions to determine if the project proposed: (1) is not likely to adversely affect listed species or destroy or adversely modify critical habitat; (2) is appropriate to append to this programmatic biological opinion; or (3) will require separate formal consultation.

4. In our letter appending proposed projects to this programmatic biological opinion, we may issue additional terms and conditions to further minimize incidental take resulting from individual proposed projects.

## CONSULTATION HISTORY

The Service, EPA, and NMFS met on numerous occasions in 1997 and 1998 to develop a proposed action that would protect and benefit listed and proposed species. In these discussions, the EPA served as representative for the LTMS agencies.

On February 23, 1998, we received your February 18, 1998, request for initiation of section 7 formal consultation, under the Act, for the proposed LTMS.

## BIOLOGICAL OPINION

### Description of the Proposed Action

The LTMS agencies will implement Alternative 3 of the EIS/EIR for the LTMS. The LTMS is a coordinated interagency program for regulating dredging and disposal of dredged materials in the Bay region over the next 50 years. The LTMS Planning Area encompasses the marine and estuarine environment and bordering lands from the Pacific Ocean's continental shelf and slope west of the Golden Gate Bridge, San Francisco, eastward to the Sacramento-San Joaquin River Delta (Delta) west of Sherman Island. Dredging is included in this consultation as an interrelated and interdependent action of the proposed project. The formal goals of the LTMS include:

1. Maintain, in an economically and environmentally sound manner, those channels necessary for navigation in the San Francisco Bay Estuary (Bay) and eliminate unnecessary dredging activities in the Bay.

2. Conduct dredged material disposal in the most environmentally sound manner.

3. Maximize the use of dredged material as a resource.

4. Establish a cooperative permitting framework for dredging and dredged material disposal applications.

Alternative 3 requires the LTMS Agencies to coordinate their efforts to affect the long term distribution of disposal of dredged materials to achieve a planned distribution of approximately 20% in-Bay disposal, 40% ocean disposal, and 40% beneficial upland/wetland reuses. Alternative 3 will dramatically reduce in-Bay disposal and increase ocean disposal and dredged material reuse. These goals will not be achieved immediately but will be phased in over time because of the present limited capacity for dredged material reuse in the Bay region.

The LTMS Agencies will develop a LTMS Comprehensive Management Plan (Management Plan). The Management Plan will be used to implement the selected alternative. Considerations for the Management Plan will include specific policies and procedures covering each of the disposal and reuse sites, as well as a description of the LTMS Agencies' joint procedures for processing and making decisions about proposed dredging projects in the Bay. The Management Plan will be reviewed periodically and updated as necessary, to reflect changing statutory, regulatory, scientific, or environmental conditions.

*Dredging*

An average of 6 million cubic yards of sediment will be dredged in the Bay/Delta Estuary each year as a result of Federal, State, local, and private maintenance dredging projects and new-work construction. Maintenance dredging includes the planned periodic removal of recently deposited sediments to maintain adequate shipping lanes, turning basins, and berths, marinas, flood control channels, and other structures. Figure 1 illustrates the distribution of some maintenance dredging projects in the action area. New-work construction includes any first-time dredging.

During dredging sediments will be removed using hydraulic and mechanical equipment. Hydraulic dredges remove loosely compacted materials by cutterheads, dustpans, hoppers, hydraulic pipeline, plain suction, and sidecasters, usually for maintenance dredging projects. Mechanical dredges remove loose or hard compacted materials by clamshell, dipper, or ladder dredges, either for maintenance or new-work projects. Mechanical dredges remove bottom sediment through direct application of mechanical force to dislodge and excavate materials. Backhoe, bucket (such as clamshell, orange-peel, and dragline), bucket ladder, bucket wheel, and dipper dredges are types of mechanical dredges.

*Transport of Dredged Materials*

Some hydraulic dredges may transport slurried dredged materials through a pipeline up to several miles directly to the disposal site. Hopper dredges simply pump dredged materials into a self-contained hopper on the dredge rather than through a pipeline, and operators often allow excess water to overflow from the hopper to increase the sediment load carried. Mechanical dredges generally place excavated sediments into a barge or scow for transport to the disposal site, and several barges may be used so that dredging is essentially continuous. Mechanical dredges may also place sediments on levees or uplands directly adjacent to the excavation site.

*Disposal of Dredged Materials*

The LTMS Plan will direct disposal of dredged materials to three placement environments: in-Bay, ocean, and upland/wetland reuse sites. In-Bay disposal will occur at open water disposal sites in Suisun Bay (SF-16), Carquinez Strait (SF-9), San Pablo Bay (SF-10), and near Alcatraz Island (SF-11) (Figure 2a). Ocean disposal will occur at the San Francisco Deep Ocean Disposal Site (SF-DODS) and at the San Francisco Bar Channel (SF-8) (Figure 2b). Disposal of dredged materials at open water disposal sites will be accomplished by direct pipeline discharge, direct mechanical placement, or releasing from hopper dredges, scows, and barges through bottom doors.

Upland/wetland reuse includes a wide variety of options that utilize the dredged material for some productive purpose, including new construction, levee maintenance, landfill cover, and marsh restoration. Some upland sites will be established as rehandling facilities, to dry dredged material for subsequent off-site use, or for confined disposal.

*Policy Level Mitigation Measures*

The LTMS Agencies will implement measures to minimize potential adverse impacts to listed and proposed threatened and endangered species, their critical habitats, and other natural resources, as described in the EIS/EIR. The proposed measures include the following general policies:

1. The LTMS Agencies will evaluate proposals for new dredged material placement or disposal sites, consistent with alternatives analysis requirements of State and Federal laws (*i.e.* NEPA, CEQA).

2. The LTMS Agencies will work to reduce the need for dredging projects in the Bay through, for example, the processes described in 1, above.

3. For any particular dredging and disposal site, LTMS Agencies will address all of the relevant contaminant exposure pathways of concern, and will include specific conditions adequate to manage the worst-case material that would be considered for placement.

4. The LTMS Agencies will require that sediments are adequately characterized physically, chemically, and biologically, and are suitable for the proposed placement environment.

5. The LTMS Agencies will develop and implement site management and monitoring plans for all multi-user disposal sites and will provide opportunity for public review and comment.

6. The LTMS agencies, together with the State Lands Commission, will cooperate in an interagency Dredged Material Management Office (DMMO) by Memorandum of Agreement (MOA) signed by the participating agencies. The DMMO will review and coordinate on proposed projects in accordance with the Management Plan.

7. The LTMS agencies will require separate review, under the Act, if any of the following upland/wetland reuses of dredged material "may affect" listed and proposed species or their critical habitats:

    a. development, expansion, or operation of dredged material rehandling facilities and dedicated confined disposal sites;

    b. wetland restoration and enhancement projects using dredged materials;

    c. development, expansion, and operation of confined aquatic disposal sites; and,

    d. use of dredged materials for levee repair and stabilization.

The LTMS agencies will also implement species-specific mitigation measures applicable to dredging and disposal of dredged material. These measures are identified in Appendix J of the EIS/EIR and are summarized below:

*California Clapper Rail and Salt Marsh Harvest Mouse*

1. Any dredging that will result in the direct or indirect loss of suitable clapper rail and harvest mouse habitat will be mitigated at a 3:1 ratio.
2. Any dredging within 250 feet of suitable clapper rail habitat will not occur during the clapper rail's breeding season from February 1 through August 31.

*California Least Tern*

The proposed restrictions do not apply to the existing disposal sites, SF-8, SF-9, SF-10, SF-11, and SF-16.

1. Separate endangered species consultation is required if any dredging or disposal activities will result in any direct or indirect impacts to eelgrass beds in the Bay.
2. Dredging in coastal waters and sloughs within 1 mile of the Bay margin from the Berkeley Marina south to San Lorenzo Creek will not be authorized from April 1 through August 31 without undergoing separate endangered species consultation, as appropriate. However, if dredging must be conducted during this time period, CDFG must be contacted and the permittee must provide an observer to identify herring spawning activity. Dredging must stop immediately if herring are within 200 meters of the work site, and may not continue until hatch-out is complete.
3. Dredging will not occur in coastal waters and sloughs in the South Bay south of the Highway 92 bridge from June 1 through September 7 without undergoing separate endangered species consultation, as appropriate.
4. Disposal activities will not occur within coastal waters, sloughs, and salt ponds in the South Bay and within 3 miles of the nesting area at Naval Air Station Alameda (NAS Alameda) without undergoing separate endangered species consultation, as appropriate.

*California Brown Pelican*

1. Disposal activities will not occur within 300 feet of known communal roost sites at the Alameda Breakwater, Angel Island, Brooks Island, and Sisters Island from April 1 through November 30 without undergoing separate endangered species consultation, as appropriate.

*Coastal Population of the Western Snowy Plover*

1. Any dredging or disposal activities that will result in the loss of suitable snowy plover habitat, including mudflat foraging habitat, will require separate endangered species consultation, as appropriate.

*Delta Smelt and Sacramento Splittail*

1. Any dredging in Suisun Bay and its tidal marshes from Carquinez Bridge east to Collinsville will require separate endangered species consultation.

2. For the delta smelt, any dredging in the Delta at times other than described below will require separate formal section 7 consultation: dredging will generally only be allowed in the southern Delta from July 1 through January 31, in the central Delta from July 1 through November 30, and in the northern Delta from August 1 through September 14. In addition, the following *Consultation and Permit Requirements* will be adhered to:

   a. Clamshell dredging shall be required whenever practicable in areas within 250 feet of a shoreline or in depths less than 20 feet.

   b. If hydraulic dredging in depths less than 20 feet, dredge head must be maintained at or below substrate surface. Head may not be raised more than 3 feet off the bottom for flushing; the pump will be shut off when raising the head more than 3 feet off the bottom (*e.g.* at end of dredging).

   c. Dredgers will implement Best Management Practices to minimize turbidity, including using silt curtains or other physical or operational measures.

3. Provided the *Consultation and Permit Requirements* described above for the delta smelt are also adhered to for the Sacramento splittail, dredging within the Delta will generally be authorized from August 1 through November 30, and within north San Pablo Bay, and Napa and Petaluma Rivers from August 1 through January 31. Dredging at any other time will require separate endangered species consultation, as appropriate.

4. In the Delta, any dredged material disposal outboard of levees will require separate formal section 7 consultation.

5. In Carquinez Strait and Suisun Bay and its tidal marshes, any dredged material disposal at sites other than SF-16, SF-9, and existing aggregate material stockpiling sites will require separate endangered species consultation, as appropriate.

6. In San Pablo Bay and its tidal marshes and Napa and Petaluma Rivers, any dredged material disposal at sites other than SF-9 and SF-10 will require separate endangered species consultation, as appropriate.

*Anadromous Fish*

Additional protective measures were incorporated in the EIR/EIS for listed and proposed anadromous fish, and will provide some benefit to delta smelt, Sacramento splittail, least terns, and brown pelicans:

1. From the San Francisco Bay Bridge upstream to Sherman Island, including any tidal sloughs, dredging will not be authorized from January 1 through May 31 without undergoing separate endangered species consultation, as appropriate. In addition to the *Consultation and Permit Requirements* listed for the delta smelt, the following also apply:

   a. Clamshell dredging will be required whenever practicable in areas within 250 feet of a shoreline or in depths less than 20 feet MLLW.

   b. If hydraulic dredging in depths less than 20 feet MLLW, dredge head must be maintained at or below substrate surface. Head may not be raised more than 3 feet off the bottom for flushing; the pump will be shut off when raising head more than 3 feet off the bottom (*e.g.* at end of dredging).

   c. For new-work projects where eelgrass will be unavoidably affected, a compensatory mitigation plan must be submitted and approved by the Service, NMFS, CDFG, and Corps.

   d. If the project will cause unavoidable direct and indirect effects to submerged or emergent vegetation, compensatory mitigation at a 3:1 ratio is required. Other proposed ratios require consultation with the Service and CDFG.

   e. Dredgers will implement Best Management Practices to reduce turbidity, including using silt curtains or other physical or operational measures).

2. In the Napa and Petaluma Rivers and Sonoma Creek, dredging will not be authorized from October 15 through June 15 without undergoing separate endangered species consultation, as appropriate.

3. Disposal of dredged materials at SF-9, SF-10, SF-11, and SF-16 will be minimized from January 1 through May 31.

**Species Account/Environmental Baseline**

*California Clapper Rail*

The clapper rail was federally listed as endangered in 1970 (35 **FR** 1604). A detailed account of the taxonomy, ecology, and biology of the clapper rail is presented in the approved Recovery Plan for this species (Service 1984). Supplemental information is provided below.

Of the 193,800 acres of tidal marsh that bordered the Bay in 1850, about 30,100 acres currently remain (Dedrick 1993). This represents an 84 percent reduction from historical conditions. Furthermore, a number of factors influencing remaining tidal marshes limit their habitat values for clapper rails. Much of the East Bay shoreline from San Leandro to Calaveras Point is rapidly eroding, and many marshes along this shoreline could lose their clapper rail populations in the future, if they have not already. In addition, an estimated 600 acres of former salt marsh along Coyote Creek, Alviso Slough, and Guadalupe Slough, has been converted to fresh- and brackish-water vegetation due to freshwater discharge from South Bay wastewater facilities and is of lower quality for clapper rails. This conversion has at least temporarily stabilized as a result of the drought since the early 1990s.

The suitability of many marshes for clapper rails is further limited, and in some cases precluded, by their small size, fragmentation, and lack of tidal channel systems and other micro-habitat features. These limitations render much of the remaining tidal marsh acreage unsuitable or of low value for the species. In addition, tidal amplitudes are much greater in the South Bay than in San Pablo or Suisun bays (Atwater *et al.* 1979). Consequently, many tidal marshes are completely submerged during high tides and lack sufficient escape habitat, likely resulting in nesting failures and high rates of predation. The reductions in carrying capacity in existing marshes necessitate the restoration of larger tracts of habitat to maintain stable populations.

Throughout the Bay, the remaining clapper rail population is besieged by a suite of mammalian and avian predators. At least 12 native and 3 non-native predator species are known to prey on various life stages of the clapper rail (Albertson 1995). Artificially high local populations of native predators, especially raccoons, result as development occurs in the habitat of these predators around the Bay margins (J. Takekawa, pers. comm.). Encroaching development not only displaces lower order predators from their natural habitat, but also adversely affects higher order predators, such as coyotes, which would normally limit population levels of lower order native and non-native predators, especially red foxes (Albertson 1995). Hunting intensity and efficiency by raptors on clapper rails also is increased by electric power transmission lines, which criss-cross tidal marshes and provide otherwise-limited hunting perches (J. Takekawa, pers. comm.). Non-native Norway rats (*Rattus norvegicus*) long have been known to be effective predators of clapper rail nests (DeGroot 1927, Harvey 1988, Foerster *et al.* 1990). Placement of shoreline riprap favors rat populations, which results in greater predation pressure on clapper rails in certain marshes. These predation impacts are exacerbated by a reduction in high marsh and natural high tide cover in marshes.

The proliferation of non-native red foxes into tidal marshes of the South Bay since 1986 has had a profound effect on clapper rail populations. As a result of the rapid decline and almost complete elimination of rail populations in certain marshes, the San Francisco Bay National Wildlife Refuge (Refuge) implemented a predator management plan in 1991 (Foerster and Takekawa 1991) with an ultimate goal of increasing rail population levels and nesting success through management of red fox predation. This program has proven successful in increasing the overall South Bay populations from an all-time low (see below); however, it has been difficult to effectively conduct predator management over such a large area as the South Bay, especially with the many constraints associated with conducting the work in urban environments (J. Takekawa, pers. comm.).

Predator management for clapper rails is not being regularly practiced in the North Bay, and clapper rail populations in this area remain susceptible to red fox predation. Red fox activity has been documented west of the Petaluma River and along Dutchman Slough at Cullinan Ranch (J. Collins, pers. comm.). Along Wildcat Creek near Richmond, where recent red fox activity has been observed, the rail population level in one tidal marsh area has declined considerably since 1987 (J. Evens, pers. comm.), even though limited red fox management was performed in 1992 and 1993 (J. Takekawa, pers. comm.).

Mercury accumulation in eggs is perhaps the most significant contaminant problem affecting clapper rails in San Francisco Bay, with the South Bay containing the highest mercury levels. Mercury is extremely toxic to embryos and has a long biological half-life. The Service collected data from 1991 and 1992 on mercury concentrations in rail eggs in the southern portion of the Estuary and found that the current accumulation of mercury in rail eggs occurs at potentially harmful levels. The percentage of non-viable eggs ranged from 24 to 38 percent (mean = 29 percent).

The clapper rail was listed as endangered primarily as a result of habitat loss. The factors described above have contributed to the more recent population reduction, which has occurred since the mid-1980s. Although Gill (1979) may have overestimated the total clapper rail population in the mid-1970s at 4,200 to 6,000 birds, surveys conducted by the CDFG and the Service estimated that the clapper rail population approximated 1,500 birds in the mid-1980s (Harvey 1988). In 1988, the total clapper rail population was estimated to be 700 individuals, with 400-500 rails in the South Bay (Foerster 1989). The total clapper rail population reached an estimated all-time historical low of about 500 birds in 1991, with about 300 rails in the South Bay (Service unpubl. data; E. Harding-Smith, pers. comm.). In response to predator management, the South Bay rail population has since rebounded from this lowest population estimate and is now estimated to be approximately 500 to 600 individuals (Service unpubl. data; J. Albertson, pers. comm.), while a conservative estimate of the North Bay population, including Suisun Bay, is 195-282 pairs (Evens and Collins 1994). Although many factors are at work, predation by native and non-native predators, in conjunction with extensive habitat loss and fragmentation, are the current primary threats. With historic populations at Humboldt Bay, Elkhorn Slough, and Morro Bay now extinct, the Bay represents the last stronghold and breeding population of this subspecies.

Evens and Page (1983) concluded from research in a North Bay marsh that the clapper rail breeding season, including pair bonding and nest construction, may begin as early as February. Field observations in South Bay marshes suggest that pair formation also occurs in February in some areas (J. Takekawa, pers. comm.). The end of the breeding season is typically defined as the end of August, which corresponds with the time when eggs laid during renesting attempts have hatched and young are mobile.

*Salt Marsh Harvest Mouse*

The harvest mouse was federally listed as endangered in 1970 (35 **FR** 1604). A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the approved Recovery Plan for this species (Service 1984). Supplemental information on the harvest mouse is provided below and in the Service's August 31, 1990, biological opinion on the Corps' permit application No. 15283E49, which is hereby incorporated by reference.

The harvest mouse occurs in remaining tidal marshes and suitable diked wetlands within the Bay eastward to the vicinity of Collinsville-Antioch. There are two subspecies of harvest mouse: the northern subspecies (*R.r. halicoetes*) occurs in Suisun and San Pablo Bays north of Point Pinole in Contra Costa County and Point Pedro in Marin County; the southern subspecies (*R.r. raviventris*) occurs in southern San Pablo Bay and central and southern portions of San Francisco Bay. Male harvest mice are reproductively active year-long, but primarily from April through September. Females have a long breeding season that extends from as early as March to November (Fisler 1965). However, they apparently have a low reproduction potential with an average litter from 3.72 to 4.21 (Fisler 1965). Fisler (1965) estimated that females of the northern subspecies may have only one litter per year. The southern subspecies may have similar productivity.

Harvest mice are endangered by loss of habitat, degradation of habitat quality, and fragmentation and isolation of remaining habitats. Of the 193,800 acres of tidal marsh that bordered the Bay in 1850, about 30,100 acres currently remain (Dedrick 1993). This represents an 84 percent reduction from historical conditions. Primary habitat for the harvest mouse historically was tidal pickleweed-dominated salt marsh and brackish marsh in the middle tidal marsh zone, complemented by natural creek levee vegetation (including tall, shrubby gumplants) and upland transition zones supporting vegetation cover which remains emergent even during the highest winter tides. Diking for agricultural reclamation and urban development eliminated the majority of both habitat components in the Bay during the 19th and early 20th century. Even though other marsh conditions may be optimal, few harvest mice survive in marshes with little or no high tide escape cover.

Substantial populations of harvest mice often occupy diked salt marshes which undergo infrequent episodes of tidal flooding, and irregular periods of inundation from impounded rainwater and runoff from adjacent uplands. Populations of harvest mice in these diked salt marshes are subject to large fluctuations in numbers, with "crashes" following periods of prolonged, deep flooding. (H. Shellhammer, San Jose State University, pers. comm.). They provide, however, important refugial populations for the species because most existing salt marsh in the San Francisco Bay Estuary is geomorphically young (formed after widespread marsh diking and reclamation), and often lacks the features of mature tidal marsh that supply ample refugia from tidal flooding, such as high densities of natural channel levees and dense, tall gumplant vegetation.

Harvest mice may be affected by mercury in the intertidal zone. Clark *et al.* (1992) found that harvest mice were captured only at sites where concentrations of mercury or PCBs were below specific levels in house mice (*Mus musculus*). Their results seem to suggest a South Bay source of mercury contamination, with mercury an order of magnitude higher in livers of house mice at Calaveras Point than at any other point measured in the Bay.

*California Least Tern*

The least tern was federally protected as endangered on October 13, 1970 (35 **FR** 16047). A detailed account of the taxonomy, ecology, and biology of the least tern is presented in the approved Recovery Plan for this species (Service 1980). Supplemental or updated information is provided in the Service's July 16, 1993, biological opinion on the Federal Aviation Administration's authorization for proposed facilities improvements at San Diego International Airport, California, which is hereby incorporated by reference.

Least terns typically arrive at NAS Alameda in mid- to late-April, but have arrived as early as April 6, and depart in mid- to late-August each year. During this time period, least tern adults mate and select nest sites; lay, incubate, and hatch eggs; and raise young to fledging prior to migrating south for the rest of the year. During the breeding season at NAS Alameda, least terns forage for fish in the open water offshore of the western end of the island, which contains extensive, generally productive foraging habitat areas. Foraging intensity has varied between different offshore areas, but has occurred in the (1) Oakland Inner Harbor, (2) Seaplane Lagoon at NAS Alameda, and (3) areas southeast, south, and west of the traditional least tern colony site. While breeding at NAS Alameda, least terns also have been reported foraging as far north as the Berkeley Marina, and as far south as San Lorenzo Creek (Laura Collins, pers. comm.).

According to the Caffrey report, the least tern breeding site at NAS Alameda has played a significant role in recent increases in the number of least terns throughout California. The NAS Alameda site is consistently one of the most successful sites in California. Between 1987 and 1994, the NAS Alameda site supported 5 to 6 percent of the statewide breeding population out of 35 to 40 sites each year, but produced an average of 10.6 percent of the total number of fledglings produced statewide in each of those years. In 1997, an estimated 244 pairs of least terns nested at the colony out of a total population of more than 4,000 nesting pairs at 37 breeding sites along the California and Baja California coasts. In 1997, an estimated 316 young fledged successfully at NAS Alameda; this represented 10.1 percent of the total number of fledglings produced throughout California that year. By consistently producing large numbers of fledglings each year, the colony has added large numbers of potential new breeding birds to the statewide population. Therefore, this site is considered to be one of the most important "source" populations in California serving to balance out losses at many "sink" locations throughout the state. Because of its importance for least terns, the Service plans to establish a National Wildlife Refuge on lands at NAS Alameda.

There are two other minor least tern breeding sites in the Bay area, the Oakland Airport and PG&E Pittsburg power plant site. The Oakland Airport site has not been used in years and the Pacific Gas and Electric Pittsburg site supports only one to four pairs each year. Therefore, the NAS Alameda site currently represents the entire Bay area population, and is the most northern of least tern breeding colonies by about 178 miles. Because of its northern location, the NAS Alameda site is relatively unaffected during El Niño years when many southern California sites experience pronounced breeding failure resulting from limited food availability. In the most recent El Niño year, 1992, the NAS Alameda site supported 6 percent of the statewide number of breeding pairs, but produced 16 percent of the total statewide number of fledglings.

*California Brown Pelican*

The pelican was protected as endangered on October 13, 1970 (35 **FR** 16047). A detailed account of the taxonomy, ecology, and biology of the pelican is presented in the approved Recovery Plan for this species (Service 1983). Supplemental or updated information is provided in the Service's September 17, 1996, biological opinion on the U.S. Bureau of Land Management's authorization for the construction of the proposed Bal'diyaka Interpretative Center in Coos Bay, Oregon, which is hereby incorporated by reference.

Pelicans arrive in northern California after their breeding season as early as April or May, but the majority of birds typically arrive in July and stay through September (D. Jaques-Strong *in* Symposium Proceedings). Breakwater Island, located in the offshore waters just south of the western end of NAS Alameda, supports the most significant loafing/night roost for brown pelicans in San Francisco Bay. Typically, Breakwater Island supports more than 400 pelicans during the nonbreeding season, but in July 1997, the island supported more than 1,000 pelicans. Other significant night roosts include Angel Island, Sisters Island, and Brooks Island (D. Jaques-Strong *in* Symposium Proceedings). Pelicans forage on fish in open water habitats. According to the EIS/EIR, post-breeding pelicans also roost at night on the Farallon Islands and forage on schooling Northern anchovy, Pacific sardine, and Pacific mackerel along the coast and along the continental shelf and upper continental slope.

*Pacific Coast Population of Western Snowy Plover*

The Pacific coast population of the plover (*Charadrius alexandrinus nivosus*) was federally listed as threatened on March 5, 1993 (50 **FR** 12864). A designation of critical habitat for the plover was federally proposed on March 2, 1995 (60 **FR** 11763).

The plover breeds primarily on coastal beaches from southern Washington to southern Baja California, Mexico. Other less common nesting habitat includes salt pans, coastal dredged spoil disposal sites, dry salt ponds, salt pond levees (Widrig 1980, Wilson 1980, Page and Stenzel 1981), and large riverine gravel bars (Gary Lester, pers. comm.). Sand spits, dune-backed beaches, unvegetated beach strands, open areas around estuaries, and beaches at river mouths are the preferred coastal habitats for nesting (Stenzel *et al.* 1981, Wilson 1980).

Plovers breed in loose colonies with the number of adults at coastal breeding sites ranging from 2 to 318 (Page and Stenzel 1981; Oregon Department of Fish and Wildlife 1994; Eric Cummins, pers. comm.). On the Pacific coast, larger concentrations of breeding birds occur in the south than in the north, suggesting that the center of the plovers' coastal distribution lies closer to the southern boundary of California (Page and Stenzel 1981). Nest sites typically occur in flat, open areas with sandy or saline substrates; vegetation and driftwood are usually sparse or absent (Widrig 1980, Wilson 1980, Stenzel *et al.* 1981). The majority of plovers are site-faithful, returning to the same breeding site in subsequent breeding seasons (Warriner *et al.* 1986).

The plover's breeding season extends from March 1 through September 30. Nest initiation and egg laying occurs from mid March through mid July (Wilson 1980, Warriner *et al.* 1986). The usual clutch size is three eggs. Both sexes participate in incubation, which averages 27 days (Warriner *et al.* 1986). Plover chicks are precocial, leaving the nest within hours after hatching to search for food. Fledging (reaching flying age) requires an average of 31 days (Warriner *et al.* 1986). Broods rarely remain in the nesting territory until fledging (Warriner *et al.* 1986, Stern *et al.* 1990).

Plovers will renest after loss of clutch or brood (Wilson 1980, Warriner *et al.* 1986). Double brooding and polygamy (*i.e.*, the female successfully hatches more than one brood in a nesting season with different mates) have been observed in coastal California (Warriner *et al.* 1986) and also may occur in Oregon (Jacobs 1986). After loss of a clutch or brood or successful hatching of a nest, plovers may renest in the same colony site or move, sometimes up to several hundred miles, to other colony sites to nest (Gary Page, pers. comm.; Warriner *et al.* 1986).

Plovers forage on invertebrates in the wet sand and amongst surf cast kelp within the intertidal zone; in dry, sandy areas above the high tide; on salt pans; spoil sites; on mudflats; and along the edges of salt marshes and salt ponds. In the Bay, breeding plovers forage on invertebrates around salt ponds, and on nearby mudflats of tidal creeks and the Bay. Only anecdotal information exists on plover food habits. Page *et al.* (1995) and Reeder (1951) listed known prey items of plovers on Pacific coast beaches and tidal flats: mole crabs (Emerita analoga), crabs

(*Pachygrapsus crassipes*), polychaetes (Neridae, *Lumbrineris zonata*, *Polydora socialis*, *Scoloplos acmaceps*), amphipods (*Corophium* spp., *Ampithoe* spp., *Allorchestes angustus*, and sand hoppers [Orchestoidea]), tanadacians (*leptochelia dubia*, flies (Ephydridae, Dolichopodidae), beetles (Carabidae, Buprestidae, Tenebrionidae), clams (*Transenella* sp.), and ostracods. Feeney (1991) described plover prey items in salt evaporation ponds in South San Francisco Bay: flies (Ephydra cinerea), beetles (*Tanarthrus occidentalis*, *Bembidion* sp.), moths (*Perizoma custodiata*) and lepedopteran caterpillars.

Plovers occur along coastal beaches and estuaries from Washington to Baja California, Mexico. Based on the most recent surveys, a total of 28 plover breeding sites or areas currently occur on the Pacific Coast of the United States. Two sites occur in southern Washington--one at Leadbetter Point, in Willapa Bay (Widrig 1980), and the other at Damon Point, in Grays Harbor (Anthony 1985). In Oregon, nesting birds were recorded in 6 locations in 1990 with 3 sites (Bayocean Spit, North Spit Coos Bay and spoils, and Bandon State Park-Floras Lake) supporting 81 percent of the total coastal nesting population (Oregon Department of Fish and Wildlife, unpubl. data, 1991). A total of 20 plover breeding areas currently occur in coastal California (Page *et al.* 1991). Eight areas support 78 percent of the California coastal breeding population: San Francisco Bay, Monterey Bay, Morro Bay, the Callendar-Mussel Rock Dunes area, the Point Sal to Point Conception area, the Oxnard lowland, Santa Rosa Island, and San Nicolas Island (Page *et al.* 1991).

The coastal population of the plover consists of both resident and migratory birds. Some birds winter in the same areas used for breeding (Warriner *et al.* 1986, Wilson-Jacobs, pers. comm. in Page *et al.* 1986). Other birds migrate either north or south to wintering areas (Warriner *et al.* 1986). Plovers occasionally winter in southern coastal Washington (Brittell *et al.* 1976), and about 70 plovers may winter in Oregon (Oregon Department of Fish and Wildlife 1994). The majority of birds, however, winter south of Bodega Bay, California (Page *et al.* 1986), and substantial numbers occur in the San Francisco Bay (Bay). Wintering coastal populations are augmented by individuals of the interior population that breed west of the Rocky Mountains (Page *et al.* 1986, Stern *et al.* 1988). Plovers winter in habitats similar to those used during the nesting season.

Poor reproductive success, resulting from human disturbance, predation, and inclement weather, combined with permanent or long-term loss of nesting habitat to encroachment of introduced European beachgrass (*Ammophila arenaria*) and urban development has led to a decline in active nesting colonies, as well as an overall decline in the breeding and wintering population of the western snowy plover along the Pacific coast of the United States. Of the 87 historic breeding areas, only 28 remain (Page and Stenzel 1981; Charles Bruce, pers. comm.; E. Cummins, pers. comm.). The nesting population in the three states is estimated to be around 1,500 adults (Page *et al.*, 1991). Page and Stenzel (1981) estimated that the South Bay supports 10% of California's breeding plovers, of which 90% can be found nesting in Alameda County salt pond systems.

*Delta smelt*

The delta smelt was federally listed as a threatened species on March 5, 1993 (58 **FR** 12854). Please refer to the Service (1993, 1994c) and Department of Water Resources (Water Resources) and Bureau of Reclamation (Reclamation) (1994) for additional information on the biology and ecology of this species. The delta smelt is a slender-bodied fish with a steely blue sheen on the sides, and it appears almost translucent (Moyle 1976). The delta smelt, which has a lifespan of one year, has an average length of 60 to 70 mm (about 2 to 3 inches) and is endemic to Suisun Bay upstream of San Francisco Bay through the Delta in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California (Figure 3). Historically, the delta smelt is thought to have occurred from Suisun Bay upstream to at least the city of Sacramento on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993). In 1996, delta smelt were also collected in the Napa River. The delta smelt is an euryhaline species (tolerant of a wide salinity range) that spawns in fresh water and has been collected from estuarine waters up to 14 parts per thousand (ppt) salinity (Moyle *et al.* 1992). For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone (saltwater-freshwater interface; also called X2), where the salinity is approximately 2 ppt (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993).

The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively constant suitable habitat conditions for the delta smelt because it could move upstream or downstream with the mixing zone (Moyle, pers. comm., 1993). The final rule to list the delta smelt as threatened describes in detail the factors that have contributed to this species' decline (Service 1993).

Shortly before spawning, adult delta smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the CVP's Tracy Pumping Plant from late December 1990 to April 1991 (Wang 1991). Spawning locations appear to vary widely from year to year (Water Resources and Reclamation 1993). Sampling of larval delta smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Dale Sweetnam, CDFG, pers. comm.; Wang 1991). Delta smelt also may spawn north of Suisun Bay in Montezuma and Suisun sloughs and their tributaries (Lesa Meng, Service, pers. comm.; Sweetnam, CDFG, pers. comm.).

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976; Wang 1986, 1991; Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), the adhesive, demersal eggs are thought to attach to substrates such as cattails, tules, tree roots, and submerged branches (Moyle 1976, Wang 1991).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were most common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1994 as cited in Water Resources and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Laboratory observations indicate that delta smelt are broadcast spawners that spawn in a current, usually at night, distributing their eggs over a local area (Lindberg 1992 and Mager 1993 as cited in Water Resources and Reclamation 1994). The eggs form an adhesive foot that appears to stick to most surfaces. Eggs attach singly to the substrate, and few eggs were found on vertical plants or the sides of a culture tank (Lindberg 1993 as cited in Water Resources and Reclamation 1994).

Delta smelt eggs hatched in 9 to 14 days at water temperatures ranging from 13° to 16° C during laboratory observations in 1992 (Mager 1992 as cited in Sweetnam and Stevens 1993). In this study, larvae began feeding on phytoplankton on day four, rotifers on day six, and *Artemia nauplii* at day 14. In laboratory studies, yolk-sac fry were found to be positively phototaxic, swimming to the lightest corner of the incubator, and negatively buoyant, actively swimming to the surface. The post-yolk-sac fry were more evenly distributed throughout the water column (Lindberg 1992 as cited in Water Resources and Reclamation 1994). After hatching, larvae and juveniles move downstream toward the mixing zone where they are retained by the vertical circulation of fresh and salt waters (Stevens *et al.* 1990). The pelagic larvae and juveniles feed on zooplankton, which typically shows highest densities in the mixing zone. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam, a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area. In general, Estuaries are among the most productive ecosystems in the world (Goldman and Horne 1993).

Observations of delta smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow-speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, delta smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50 percent for "stroke and glide" swimming compared to steady swimming. However, the maximum speed delta smelt are able to achieve using this preferred mode of swimming, or gait, was less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile delta smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the fish were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Unlike fish for which this type of measurement has been made in the past, delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (*e.g.*, metabolic scope for activity; Brett 1976).

Adult delta smelt spawn in central Delta sloughs from February through August in shallow water areas having submersed aquatic plants and other suitable substrates and refugia. These shallow water areas have been identified in the draft Delta Native Fishes Recovery Plan (Service 1994c) as essential to the long-term survival and recovery of delta smelt and other resident fish. A no net loss strategy for these areas is proposed in this Recovery Plan.

The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the mixing zone (Peter Moyle, UCD, pers. comm.). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to increased siltation and alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to the degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of drought and the steadily increasing proportion of river flow being diverted from the Delta by the CVP and SWP (Monroe and Kelly 1992). Figure 7 shows the relationship between the portion of the delta smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988 (Water Resources and Reclamation 1994). This relationship indicates that the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cfs, placing X2 between Chipps and Roe islands. Placement of X2 at Chipps and Roe islands would duplicate these favorable conditions.

*Delta Smelt Critical Habitat*

On December 19, 1994, a final rule designating critical habitat for the delta smelt was published in the *Federal Register* (59 **FR** 65256; Service 1994b). Please refer to the Service (1994b) for additional information on delta smelt critical habitat.

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and (5) generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat, the Service identified the following primary constituent elements essential to the conservation of the delta smelt: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Critical habitat for delta smelt is contained within Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Figure 4).

*Spawning Habitat.* Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and the tributaries of northern Suisun Bay.

*Larval and Juvenile Transport.* Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay, and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped," leading to an area of high productivity, is associated with its location (Figure 5). Placement of X2 in Suisun Bay substantially increases the amount of optimal salinity habitat available to delta smelt (Unger 1994). This is supported by a statistically significant relationship between the number of days that X2 is in Suisun Bay (during February and June) and delta smelt fall midwater trawl abundance (Herbold 1994). Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

*Rearing Habitat*. An area extending eastward from Carquinez Straits, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts from the beginning of February to the end of August.

*Adult Migration*. Adequate flows and suitable water quality are needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods. The Service's 1994 and 1995 biological opinions on the CVP and SWP provided for larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1994a, 1995).

Critical habitat has been affected by dredging, pile driving, and other actions that destroy spawning and refugial areas. Critical habitat has also been affected by diversions that have shifted the position of X2 upstream. This shift has caused a decreased abundance of delta smelt. Existing baseline conditions and implementation of the Service's 1993 and 1994 biological opinions provide a substantial part of the necessary positive riverine flows and estuarine outflows to transport delta smelt larvae downstream to suitable rearing habitat in Suisun Bay outside the influence of marinas and Federal and State pumping plants.

*Sacramento Splittail*

The splittail (*Pogonichthys macrolepidotus*) was listed as threatened on February 8, 1999 (64 **FR** 5963; Service 1999). Please refer to the Service (1999, 1994c, 1995), and Water Resources and Reclamation (1994) for additional information on the biology and ecology of the splittail.

The splittail is a large cyprinid that can reach greater than 12 inches in length (Moyle 1976). Adults are characterized by an elongated body, distinct nuchal hump, and a small blunt head with barbels usually present at the corners of the slightly subterminal mouth. This species can be distinguished from other minnows in the Central Valley of California by the enlarged dorsal lobe of the caudal fin. Splittail are a dull, silvery-gold on the sides and olive-grey dorsally. During the spawning season, the pectoral, pelvic and caudal fins are tinged with an orange-red color. Males develop small white nuptial tubercles on the head.

Splittail are endemic to California's Central Valley where they were once widely distributed in lakes and rivers (Moyle 1976). Historically, splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found splittail as far upstream as the current Oroville Dam site on the

Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more splittail per day prior to damming of these rivers (Caywood 1974). Splittail were common in San Pablo Bay and Carquinez Strait following high winter flows until about 1985 (Messersmith 1966, Moyle 1976, and Wang 1986 as cited in Department and Reclamation 1994).

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range (Moyle and Yoshiyama 1989). Splittail enter the lower reaches of the Feather (Jones and Stokes 1993) and American rivers (Charles Hanson, State Water Contractors, *in litt.*, 1993) on occasion, but the species is now largely confined to the Delta, Suisun Bay, and Suisun Marsh (Service 1999). Stream surveys in the San Joaquin Valley reported observations of splittail in the San Joaquin River below the mouth of the Merced River and upstream of the confluence of the Tuolumne River (Saiki 1984 as cited in Water Resources and Reclamation 1994).

Splittail are long-lived, frequently reaching five to seven years of age. Generally, females are highly fecund, producing over 100,000 eggs each year (Daniels and Moyle 1983). Populations fluctuate annually depending on spawning success. Spawning success is highly correlated with freshwater outflow and the availability of shallow-water habitat with submersed, aquatic vegetation (Daniels and Moyle 1983). Splittail usually reach sexual maturity by the end of their second year at which time they have attained a body length of 180 to 200 mm. There is some variability in the reproductive period because older fish reproduce before younger individuals (Caywood 1974). The largest recorded individuals of the splittail have measured between 380 and 400 mm (Caywood 1974, Daniels and Moyle 1983). Adults migrate into fresh water in late fall and early winter prior to spawning. The onset of spawning is associated with rising water temperature, lengthening photoperiod, seasonal runoff, and possibly endogenous factors from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). Spawning occurs in water temperatures from 9° to 20° C over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs, and slow-moving reaches of large rivers. The eggs are adhesive or become adhesive soon after contacting water (Caywood 1974, and Bailey, UCD, pers. comm., 1994, as cited in Water Resources and Reclamation 1994). Larvae remain in shallow, weedy areas close to spawning sites and move into deeper water as they mature (Wang 1986).

Splittail are benthic foragers that feed on opossum shrimp, although detrital material makes up a large percentage of their stomach contents (Daniels and Moyle 1983). Earthworms, clams, insect larvae, and other invertebrates are also found in the diet. Predators include striped bass and other piscivores. Splittail are sometimes used as bait for striped bass.

Splittail can tolerate salinities as high as 10 to 18 ppt (Moyle 1976, Moyle and Yoshiyama 1992). Splittail are found throughout the Delta (Turner 1966), Suisun Bay, and the Suisun and Napa marshes. They migrate upstream from brackish areas to spawn in freshwater. Because they require flooded vegetation for spawning and rearing, splittail are frequently found in areas subject to flooding.

The 1985 to 1992 decline in splittail abundance is concurrent with hydrologic changes to the Estuary. These changes include increases in water diversions during the spawning period from January through July. Diversions, dams and reduced outflow, coupled with severe drought years, introduced aquatic species, and loss of wetlands and shallow-water habitat have reduced the species' capacity to reverse its decline (Moyle *et. al.* 1992). Please refer to 59 **FR** 862 and Water Resources and Reclamation (1994) for additional information on the biology and ecology of the splittail.

Splittail have experienced a decline in population as a result of hydrologic changes in the Estuary and loss of shallow water habitat due to dredging and filling. Additional changes include increases in water diversions during the spawning period of January through July. Most of the factors that caused delta smelt to decline have also caused the decline of splittail. These factors include (1) diversions, (2) dams and (3) reduced outflow, coupled with (4) severe drought years, (5) introduced aquatic species such as the Asiatic clam (Nichols *et al.* 1990), and (6) loss of wetlands and shallow-water habitat (CDFG 1992) and appear to have perpetuated the species' decline.

**Effects of the Action**

Implementation of the proposed project is likely to result in harassment and injury or death to individual harvest mice, delta smelt, and splittail, and harm to clapper rails, harvest mice, least terns, pelicans, snowy plovers, delta smelt, and splittail through the permanent and/or temporary loss of their habitat and/or degradation of habitat quality.

*California Clapper Rail and Salt Marsh Harvest Mouse*

*Habitat Loss*

The LTMS could result in temporary and permanent, direct and indirect loss of suitable clapper rail and harvest mouse habitat. Dredging could result in the direct removal of vegetated habitat used by these species and mudflats used by foraging clapper rails. In addition, suitable clapper rail and harvest mouse habitat could be temporarily lost through the direct placement or incidental slippage of dredged materials. An indirect loss of clapper rail and harvest mouse habitat could occur if dredging activities cause slumping of the habitats used by these species from the sides of dredged areas. Dredged materials placed on adjacent levees could result in increased predation by eliminating important upland hiding cover used by clapper rails and harvest mice during high tides. Evens and Page (1986) observed that predation on several species of rails appeared to be greatest during high tides when flooded marshes provided minimal vegetative cover. Maintenance dredging, such as in tidal sloughs which also serve as County flood control channels, can result in temporary and permanent-like impacts to clapper rails and harvest mice. These periodic, temporary impacts, which can repeatedly diminish habitat value and prevent the full development of tidal marsh, result in "permanent-like" impacts to the clapper rail and harvest mouse.

*Contaminant Related Effects*

Mercury pollution is prevalent in the Bay, especially the South Bay. Clapper rails are exposed to mercury through their diet, which consists primarily of benthic invertebrates that forage on detritus and plankton (J. Albertson, pers. comm.; Eddleman and Conway 1994; Varoujean 1972; Test and Test 1942; Moffitt 1941; Williams 1929). According to the EIS/EIR, dredging of contaminated sediments could potentially release contaminants to the water column and result in their uptake by organisms contacting resuspended materials. In 1995 and 1996 the Service studied the potential to increase mercury concentrations in prey items of the clapper rail as a result of dredging and stockpiling sediments in tidal marsh. The study found that dredging and spoiling sediments in tidal marsh significantly increased mercury concentrations in clapper rail prey items 30 days after dredging, possibly to levels toxic to rail eggs. However, since the LTMS will not authorize disposal of dredged materials in tidal marsh except through separate formal section 7 consultation, the effects of LTMS on the bioavailability of mercury to clapper rails is expected to be minimal.

*California Least Tern and California Brown Pelican*

*Loss and Reduction in the Quality of Tern and Pelican Foraging Habitat*

Dredging and in-water construction activities within the Bay and disposal of dredged sediments at designated disposal sites could result in increased turbidity and dispersal of contaminated sediments in least tern and pelican foraging areas. Collins (1995) summarized least tern prey selection studies at NAS Alameda from 1981 to 1995. Researchers counted fish, by species, dropped by least terns flying between foraging and nesting areas. Although studies of dropped fish do not provide direct evidence of prey consumed, they do provide a good indication of least tern diets. Northern anchovy (*Engraulis mordax*), San Francisco topsmelt (*Atherinops affinis affinis*), jacksmelt (*Atherinops californiensis*), and unidentified Atherinidae species comprised 85.4 percent of the total percentage of fish collected at the least tern colony. Pelicans prey upon northern anchovies as a food source. Northern anchovies mostly spawn in open waters of the Pacific Ocean, but eggs are abundant in San Francisco Bay from May through September (Herbold *et al.* 1992). Within San Francisco Bay, northern anchovies spawn in channels, but larvae mostly occur in shallow water areas (McGowan 1986). While anchovy larvae have been documented to tolerate lower water clarity than anchovy eggs, eggs were found to be most abundant in parts of San Francisco Bay with low concentrations of zooplankton and clearer water (Herbold *et al.* 1992). This information suggests that decreased water clarity associated with dredging and disposal of dredged sediments could reduce the productivity and/or availability of northern anchovies, a principal fish prey item for least terns and pelicans.

Anchovy adults and juveniles typically enter San Francisco Bay in April and leave in the fall (Herbold *et al.* 1992). Large numbers of northern anchovies are present in central San Francisco Bay in May, June, and July (Figure 42 in Herbold *et al.* 1992). San Francisco topsmelt spawn in San Francisco Bay from April to October with peak spawning in May and June (Wang 1986). Jacksmelt adults enter bays and estuaries in late winter and early spring to spawn, and spawn in San Francisco Bay from October to early August (Wang 1986). Both San Francisco topsmelt and jacksmelt use submerged vegetation, including eelgrass, as a spawning substrate. Increased turbidity associated with dredging, sediment overflow from barges, and disposal of dredged sediments at locations in the Bay could either individually or collectively reduce in-water visibility for least terns and pelicans at the water surface and at shallow depths, thus reducing their overall foraging effectiveness. These adverse effects could be most pronounced during June and July each year when least tern adults are feeding unfledged young. Unfledged young have high energetic needs for growth and development, thus requiring large amounts of food relative to their body size. Further, sediment dispersed during dredging operations could cover eelgrass and reduce light in eelgrass beds outside of dredging boundaries, thus reducing their productivity and suitability as fish spawning habitat.

*Contaminant-related Effects*

The proposed dredging and disposal of dredged materials in the Bay could increase contaminant-related adverse effects to least terns and pelicans in several ways. Topsmelt embryos and larvae can be affected by pollution (Singer *et al.* 1990, Anderson *et al.* 1991, Goodman *et al.* 1991 Hemmer *et al.* 1991), and jacksmelt also may be impacted by pollution. Egg shell thinning by pelicans has been attributed to high levels of DDT. According to the EIS/EIR, sediments within the action area proposed for dredging are known to be contaminated with heavy metals, including PCBs, PAHs, and DDT. Increased suspension of contaminated sediments could reduce productivity and the abundance of suitable fish prey for least terns and pelicans. Increased boat and ship activity associated with dredging operations also could increase the risk of spillage events in least tern and pelicans foraging areas.

*Western snowy plover*

The dredging and excavation of sediments in San Pablo Bay and the South Bay has the potential to affect plovers both directly and indirectly. Dredging activities in close proximity to breeding plovers could result in harassment and death of snowy plovers. Disturbance could cause courting adults to abandon potential breeding habitat for less preferred habitat elsewhere, and could delay the onset of nesting activities reducing the number of nesting attempts and productivity that year. In addition, disturbance could cause nesting adults to abandon active nests resulting in the direct loss of fertile eggs. Breeding plovers are most susceptible to disturbance and are most likely to abandon nests during egg laying and early incubation stages. Dredging and excavation could also result in the direct and indirect loss of suitable mudflat foraging habitat by direct excavation or subsequent sloughing of steep banks. However, the LTMS agencies will require separate formal section 7 consultation for projects resulting in direct or indirect loss of suitable snowy plover habitat.

*Delta Smelt and Sacramento Splittail*

The dredging and excavation of bottom material from sloughs and rivers in the Bay and Delta at depths of 3m or less, at mean lower low water, has the potential to affect delta smelt and splittail directly and indirectly. Because these species utilize shallow water areas for breeding, they, or the eggs they may lay, may be directly taken as a result of the dredging and or excavation operations. Eggs laid that are not directly taken by dredging activities may remain unfertilized as adults are chased from the project site by the dredgers. Eggs could also become covered by silt stirred up by dredging operations and suffocated.

If dredging results in the loss of shallow water habitat, such as *Typha* and *Scirpus*, the habitat upon which the these species depend would be diminished. This in turn would remove habitat used as shelter from predatory species, such as piscivorous birds, fish, *etc.*; or could reduce the functional ecosystem upon which their foraging base relies. Loss of shallow water habitat could force the delta smelt and splittail to seek alternative habitat which may be located in less desirable areas in the Bay and Delta. Clamshell dredges sometimes leave pockets of deeper water that isolate delta smelt and splittail at low tide. Entrapped fish may become susceptible to temperature increases, limited in natural behavior, or more susceptible to predation. Because the Sacramento/San Joaquin Delta Native Fishes Recovery Plan calls for no net loss of shallow water habitat, the survival and recovery of delta smelt would be limited by dredging activities, thus, habitat would need to be replaced.

**Cumulative Effects**

Cumulative effects are those impacts of future State, Tribal, local, or private actions affecting listed species that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they require separate consideration pursuant to section 7 of the Act.

Cumulative effects on the clapper rail include ongoing habitat conversion from salt to brackish conditions by fresh water effluent from the San Jose/Santa Clara Water Pollution Control Plant. The San Francisco Bay Regional Water Quality Control Board routinely renews discharge permits that allow marsh conversion to continue. The most recent permit renewal contained a mitigation measure to replace about 275 acres of former salt marsh that has converted to largely unsuitable brackish marsh conditions. Successful implementation of the pending tidal marsh restoration project for the Baumberg Tract would mitigate for this habitat loss. The City of San Jose currently is exploring potential reuse measures to reduce their discharges in the future. Other cumulative effects include chemical contamination from point and non-point discharges that may adversely affect survival rates and reproductive success.

One of the most serious cumulative effects on the harvest mouse has been the degradation of diked wetlands, typically by the elimination of wetland vegetation by grazing, discing, grubbing, and plowing, and/or the elimination of appropriate hydrologic conditions by installing drains, ditches, and pumps. The extensive conversion of South Bay salt marshes to brackish and freshwater habitat also has appreciably reduced available tidal habitat for this species.

The most serious cumulative effect on least terns in the Bay is the degradation of the Oakland International Airport nesting site as a result of red fox predation over several years. The Service has recently approached the Port, which has operational responsibility for some activities at the Oakland Airport, about conducting predator management, vegetation removal, and other activities to enhance and sustain least tern nesting activities at the Oakland Airport. However, the Port has not fully developed and implemented management actions at the Oakland Airport that would provide adequate protection for least terns nesting at the Oakland Airport. Long term loss of the Oakland nesting site would leave only one nesting site in the Bay at NAS Alameda. The current situation with only one viable nesting site in the Bay makes this endangered species highly vulnerable to stochastic extinction in the Bay.

The plover is subject to a wide range of cumulative effects because it breeds and winters on sandy beaches along the Pacific coast from Washington to Baja California, on dredged spoils sites and salt pond levees around the San Francisco Bay Estuary, and on gravel bars of the Eel River, California. Activities affecting the plover include, but are not limited to, sand excavation projects, beach raking, dogs off leash, dune stabilization or restoration through reestablishment of vegetation, daytime and nighttime vehicle use, falconry, domestic and feral animal predation, and oil spills.

Cumulative effects on splittail, delta smelt or its proposed critical habitat include any continuing or future non-Federal diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally, thus shifting upstream the position of the delta smelt's preferred habitat. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, as well as providing water for power plants. State or local levee maintenance and channel dredging activities also destroy or adversely modify critical habitat by disturbing spawning or rearing habitat. Delta smelt adults seek shallow, tidally-influenced, fresh water (*i.e.*, less than 2 ppt salinity) backwater sloughs and edgewaters for spawning. To assure egg hatching and larval viability, spawning areas also must provide suitable water quality (*i.e.*, low concentrations of contaminants) and substrates for egg attachment (*e.g.*, submersed tree roots, branches, and emersed vegetation). Suitable water quality must be provided by addressing point sources of contaminants so that maturation is not impaired by pollutant concentrations. Levee maintenance disturbs spawning and rearing habitat, and re-suspends contaminants into these waters.

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt and splittail, these contaminants may adversely affect delta smelt and splittail reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

The Service is not aware of any cumulative effects on pelicans in the action area.

**Conclusion**

After reviewing the current status of the clapper rail, salt marsh harvest mouse, least tern, pelican, Pacific Coast population of the plover, delta smelt, and splittail, the environmental baseline for the action area, the effects of the proposed LTMS and the cumulative effects, it is the Service's biological opinion that the LTMS, as proposed, is not likely to jeopardize the continued existence of the clapper rail, harvest mouse, least tern, pelican, Pacific Coast population of plover, delta smelt, and splittail, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for the clapper rail, harvest mouse, least tern, pelican, and splittail; therefore none will be destroyed or adversely modified. Critical habitat has been designated for the delta smelt, but the action is not likely to result in destruction or adverse modification of critical habitat. Critical habitat has been proposed for designation for the plover, but none will be adversely modified or destroyed.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act, and Federal regulation pursuant to section 4(d) of the Act, prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as actions that create the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the EPA and Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The EPA and Corps have a continuing duty to regulate the activity covered by this incidental take statement. If the EPA and Corps (1) fail to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

**Amount or Extent of Take**

For the clapper rail, we anticipate incidental take will be difficult to detect, due to the nature of the potential effects, the shy nature of the bird, and the variable population that may be present through time. Due to the difficulty in quantifying the number of clapper rails that will be taken as a result of the proposed action, we are quantifying incidental take as the number of acres of habitat that will be lost. We anticipate clapper rails may be harmed or harassed by heavy equipment and habitat loss or alteration. We anticipate an unquantifiable number of clapper rails may be killed, harmed, or harassed as a result of the temporary and permanent loss of no more than 20 acres of clapper rail habitat in the Bay each year. Implementation of proposed mitigation measures will mitigate for these impacts.

For the harvest mouse, we anticipate incidental take will be difficult to detect because of the variable, unknown size of the resident population over time, and the difficulty in finding killed or injured small mammals. Due to the difficulty in quantifying the number of harvest mice that will be taken as a result of the proposed action, we are quantifying incidental take as the number of acres of habitat that will be lost. We anticipate harvest mice may be killed, harmed, or harassed by heavy equipment, and habitat loss or alteration. We anticipate an unquantifiable number of harvest mice may be killed, harmed, or harassed as a result of the temporary and permanent loss of no more than 20 acres of harvest mouse habitat in the Bay each year. Implementation of the proposed mitigation measures will compensate for these impacts.

For the least tern, we anticipate incidental take will be difficult to detect, due to the nature of the potential effects and the variable population that may be present through time. Least terns may be harmed or harassed by dredging and disposal activities that occur in the Bay. However, the proposed project will not result in any direct loss of least tern nesting habitat, nor any permanent loss of foraging habitat. While it is difficult to quantify the amount of incidental take associated with the proposed action, we anticipate harm and harassment to as many as 244 least tern breeding pairs in any given year. This amount of incidental take could be greater in any given year if the number of breeding pairs at the NAS Alameda colony site increases, and/or if additional colonies become established. It is difficult to quantify the incremental increase in mortality of least tern adults and/or their eggs and/or chicks from the proposed action, however, we anticipate (1) the fledgling-to-pair ratio in any given year would not be lower than 0.7, or (2) the average fledgling-to-pair ratio during any 3-year period would not be lower than 1.1.

We anticipate incidental take of pelicans will be difficult to detect due to the nature of the potential effects and the variable population that may be present through time. We anticipate pelicans may be harmed or harassed by dredging and disposal activities in the Bay. No direct loss of pelican nighttime roosting habitat is anticipated for the proposed action. While it is difficult to quantify the amount of incidental take associated with the proposed action, we anticipate harm and harassment to as many as 100 pelicans in any given year could result from disturbance associated with the proposed action, and temporary adverse effects to foraging habitat associated with authorized dredging in the Bay and disposal operations at SF-9, SF-10, SF-11, and SF-16.

For the plover, we anticipate incidental take will be difficult to detect due to the nature of the potential effects and the variable population that may be present through time. Due to the difficulty in quantifying the number of plovers that will be taken as a result of the proposed action, we are quantifying incidental take as the number of acres of habitat that will be lost. We anticipate plovers may be harmed or harassed by dredging and disposal activities. No direct loss of suitable plover breeding habitat is anticipated for the proposed action. We anticipate plovers may be harmed and harassed by heavy equipment and habitat loss or alteration. We anticipate an unquantifiable number of plovers may be harmed and harassed as a result of the permanent loss of no more than 5 acres of suitable plover mudflat foraging habitat in the Bay each year. Implementation of the proposed mitigation measures will compensate for these impacts.

The Service anticipates an unquantifiable number of delta smelt and splittail could be taken annually as a result of the proposed action. The incidental take is expected to be in the form of harm, harass and kill. Because the species are wide-ranging and their distribution varies from one year to the next; take may vary from year to year. Additionally, losses of the species may be masked by seasonal fluctuations in numbers. Due to the difficulty in quantifying the number of delta smelt and splittail that will be taken as a result of the proposed action, we are quantifying incidental take as the number of acres of habitat that will be lost. We anticipate an unquantifiable number of delta smelt and splittail may be harmed and harassed as a result of the permanent loss of no more than 10 acres of shallow water habitat each year. Implementation of the proposed mitigation measures will compensate for these impacts.

The Service has developed this incidental take statement based on the premise that the reasonable and prudent measures will be implemented. Upon implementation of the following reasonable and prudent measure(s), the incidental take associated with the LTMS, described above, will become exempt from the prohibitions described under section 9 of the Act. No other forms of take are authorized under this opinion.

**Effect of the Take**

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the clapper rail, salt marsh harvest mouse, least tern, pelican, Pacific coast population of plover, delta smelt, and splittail, and not result in the destruction or adverse modification of critical habitat.

## Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the clapper rail, salt marsh harvest mouse, least tern, pelican, Pacific coast population of plover, splittail, and delta smelt and its critical habitat:

The potential for harassment, harm, or mortality to the clapper rail, harvest mouse, least tern, pelican, Pacific coast population of the plover, splittail, and delta smelt and its critical habitat shall be minimized.

## Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the EPA and Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary. The EPA and Corps shall ensure the project is implemented as proposed, except for the following additions and modifications:

1. The EPA and Corps shall modify the mitigation ratio for impacts to suitable clapper rail and harvest mouse habitats, which is proposed as 3:1. Greater or lesser ratios may be authorized for individual projects based upon habitat quality at the impact site and mitigation site, but shall not be less than 2:1.

2. The EPA and Corps shall modify the timing of the restriction on dredging in least tern foraging habitat from the Berkeley Marina to San Lorenzo Creek to extend from March 15 through July 31. Within this area, silt curtains or other physical or operational measures shall be employed during any dredging operations to minimize sediment dispersal into adjacent least tern and pelican foraging areas beyond the footprint of the dredged areas. The EPA and Corps shall eliminate the proposed exception to the timing window which would allow dredging to occur if CDFG was contacted and an observer documented there were no herring spawning within 200 meters of the work site.

3. The proposed restriction that prohibits dredging within 300 feet of the pelican night-time roosts from April 1 through November 30 shall be modified. The new restriction shall prohibit dredging and disposal activities within 300 feet of known night-time communal roosts from July 1 through September 30, and only during the time period between one hour before sunset to sunrise.

4. The LTMS agencies shall not authorize any dredging projects east of Sherman Island in the Sacramento-San Joaquin River Delta (Delta) without completing separate endangered species consultation, as appropriate. Proposed dredging projects in the Delta may be authorized through the Service's programmatic formal consultation and conference with the Corps' Sacramento District (Service File No. 1-1-97-F-91).

5. The EPA and Corps shall include a condition requiring that shallow water habitat in Suisun Bay lost as a result of dredging be mitigated at a 3:1 ratio, in kind, and in the vicinity of the project site (Consultation and Permit Requirement D in the EIS/EIR). For the delta smelt and splittail, shallow water habitat is defined as waters less than 3 meters deep at mean lower low water. If a Service approved mitigation bank is established (*e.g.*, Kimball Island) an equal number of credits as defined in the Mitigation Bank Enabling Instrument may be purchased to offset impacts to shallow water habitat construction. A copy of a Mitigation Bank invoice shall be provided to the Service prior to startup of project.

6. The EPA and Corps shall submit the Management Plan, including the additions and modifications described above, for the Service's review and approval prior to finalization and implementation.

**Reporting Requirements**

We shall be notified within twenty-four (24) hours of the finding of any injured or dead listed and proposed species, or any unanticipated harm to their habitat addressed in this biological opinion. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact person is the Chief, Endangered Species Division in the Sacramento Fish and Wildlife Office (916-979-2725). Any dead or injured specimen shall be preserved according to standard museum practices and deposited with the Service's Division of Law Enforcement, 3310 El Camino Avenue, Suite 140, Sacramento, California 95821-6340 (916-979-2987). Any killed delta smelt and splittail that have been taken shall be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10% formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information shall be written on 100% rag content paper with permanent ink and included in the container with the specimen. Any killed listed birds and mammals shall be placed in a sealed plastic bag and frozen. Information concerning how the individual was taken, length of the interval between death and preservation, the date, time, and precise location it was taken, and any other relevant information shall be written on 100% rag content paper with permanent ink and included in the container with the specimen.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service proposes the following conservation recommendations:

1. Help to establish mitigation banks to compensate for the loss of listed species habitat resulting from projects authorized under LTMS.

2. Contribute to predator management activities to enhance the value of preserved and mitigation habitats.

3. Study the bioavailability of contaminants to listed species during and following dredging and dredged material disposal events.

4. Contribute to control of non-native flora and fauna in the Bay and Delta.

5. The EPA and Corps should use their authority to further the purposes of the Act by implementing, or sharing the implementation of, approved Recovery Plans for species affected by the LTMS project. Relevant plans include the approved Delta Native Fishes Recovery Plan, and the draft San Francisco Bay Tidal Marsh Recovery Plan, which is expected to be available to the public in 1999.

## REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the proposed LTMS project. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If you have any questions regarding this opinion, please contact Dan Buford (birds/mammals) or Matthew Vandenberg (fish) at (916) 979-2752.

Sincerely,

Karen J. Miller

for Cay C. Goude
Acting Field Supervisor

Enclosures

cc: PARD (ES), Portland, OR
CESF, Planning Branch, San Francisco, CA
CESF, Regulatory Division, San Francisco, CA
NMFS, Santa Rosa, CA
CDFG, Yountville, CA
BCDC, San Francisco, CA
SFBRWQCB, Oakland, CA
SWRCB, Sacramento, CA

## LITERATURE CITED


Albertson, J.D. 1995. Ecology of the California Clapper Rail in South San Francisco Bay. M.A. Thesis, San Francisco State University

Anderson, B.S., D.P. Middaugh, J.W. Hunt, and S.L.Turpen. 1991. Copper toxicity to sperm, embryos and larvae of topsmelt, *Atherinops affinis*, with notes on induced spawning. Mar. Environ. Res. 31:17-35.

Anthony, J.L. 1985. A report on the distribution, numbers and human disturbance of snowy plovers at Damon Point, Washington. Report to the Washington Department of Game. Evergreen State College, Washington. 24 pp.

Arthur, J.F. and M.D. Ball 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

Arthur, J.F. and M.D. Ball 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California.

Arthur, J.F. and M.D. Ball 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Atwater, B., S. Conrad, J. Dowden, C. Hedel, R. MacDonald, and W. Savage. 1979. History, landforms, and vegetation of the Estuary's tidal marshes *in*: T.J. Conomos (ed.): San Francisco Bay, the urbanized Estuary. Pacific Div., Am. Assoc. for the Adv. of Sci. 58th annual mtg., S.F. State Univ., June 12-16, 1977.

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon, *Oncorhynchus nerka*, and some related energetics. J. Fish. Res. Bd. Can. 33:307-313.

Brittell, J.D., J.M. Brown, and R.L. Eaton. 1976. Marine shoreline fauna of Washington, Vol. II. Washington Department of Game and Ecology, Olympia, Washington. 10 pp.

California Department of Fish and Game 1992. Draft five year status report. CDFG, Inland Fish. Div.

Caywood, M.L. 1974. Contributions to the Life History of the Splittail *Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State U., Sacramento. 77 pp.

Clark, D.R., Jr., K.S. Foerster, C.M. Marn, and R.L. Hothem. 1992. Uptake of environmental contaminants by small mammals in pickleweed habitats at San Francisco Bay, California. Arch. Environ. Contam. Toxicol. 22:389-396.

Collins, L.D. 1995. California least tern nesting season at the Alameda Naval Air Station 1995. Report prepared for the U.S. Navy under contract no. N62474-95-C-2556. 62 pp.

Daniels, R.A. and P.B. Moyle 1983. Life history of splittail (Cyprinidae: *Pogonichthys macrolepidotus*) in the Sacramento-San Joaquin Estuary. Fishery Bulletin 84-3:647-654.

Dedrick, K. 1993. San Francisco Bay tidal marshland acreages: recent and historic values. In O.T. Magoon (ed.): Proceedings of the Sixth Symposium on Coastal and Ocean Management (Coastal Zone '89). Charleston, South Carolina, July 11-14, 1989. Publ. by Am. Society of Civil Eng.

DeGroot, D.S. 1927. The California clapper rail: its nesting habits, enemies and habitat. Condor 29 (6): 259-270.

Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. 134 pp.

Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. 230 pp.

Eddleman, W.R., and C.J. Conway. 1994. Clapper rail. *In* T.C. Tacha and C.E. Braun (ed.): Migratory Shore and Upland Game Bird Management in North America. Allen Press, Lawrence, Kansas. 223 pp.

Evens, J., and J. Collins. 1994. A synoptic survey of the distribution and abundance of the California clapper rail *Rallus longirostris obsoletus* in the northern reaches of the San Francisco Estuary during the 1992 and 1993 breeding seasons. Draft Technical Report to California Department of Fish and Game. 22 pp.

Evens, J., and G. Page. 1983. The ecology of rail populations at Corte Madera Ecological Reserve: with recommendations for management. A report to Marin Audubon Society from Point Reyes Bird Observatory. 62 pp.

Feeney, Leora R. 1991. Snowy plovers and their habitat at the Baumberg area and Oliver salt ponds, Hayward, California, March 1989 through May 1990. Unpubl. Rep., The City of Hayward, 161 pp.

Fisler, G.F. 1965. Adaptations and speciation in harvest mice of the marshes of San Francisco Bay. University of California Publications in Zoology, Volume 77. University of California Press, Berkeley, CA. 108 pp.

Foerster, K.S., and J.E. Takekawa. 1991. San Francisco Bay National Wildlife Refuge Predator Management Plan and Final Environmental Assessment. Unpublished report.

Foerster, K.S., J.E. Takekawa, and J.D. Albertson. 1990. Breeding density, nesting habitat, and predators of the California clapper rail. Final report SFBNWR-11640-90-1, prepared for San Francisco Bay National Wildlife Refuge. Newark, CA.

Foerster, K.S. 1989. Summary of California clapper rail winter populations in the San Francisco Bay National Wildlife Refuge, Nov. 1988 to Jan. 1989. Unpublished report. San Francisco Bay National Wildlife Refuge.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 *in* D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fish Bulletin No. 133.

Gill, R., Jr. 1979. Status and distribution of the California clapper rail (*Rallus longirostris obsoletus*). Calif. Fish and Game, 65 (1): 36-49.

Goldman, C.R. and A.J. Horne 1983. Limnology. McGraw-Hill Book Company, New York, New York.

Goodman, L.R., M.J. Hemmer, D.P. Middaugh, and J.C. Morre. 1991. Effects of fenvalerate on the early life stages of topsmelt (*Atherinops affinis*). Environ. Toxicol. Chem. 11:409-414.

Harvey, T.E. 1988. Breeding biology of the California clapper rail in south San Francisco Bay. 1988 Transactions of the Western Section of the Wildlife Society. 24:98-104.

Hemmer, M.J., D.P. Middaugh, and V. Comparetta. 1991. Comparative acute sensitivity of larval topsmelt, *Atherinops affinis*, and inland silversides, Menidia beryllina, to 11 chemicals. Environ. Toxicol. Chem. 11:401-408.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Program Newsletter. Winter 1994:1-3.

Jacobs, R.A. 1986. Snowy plover (*Charadrius alexandrinus*). Section 4.4.1, U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-86-54, Portland, Oregon. 25 pp.

McGowan, M.F. 1986. Northern anchovy, *Engraulis mordax*, spawning in San Francisco Bay, California 1978-1979, relative to hydrography and zooplankton prey of adults and larvae. Fish. Bull., U.S. 84(4):879-894.

Messersmith, J.D. 1966. Fishes collected in Carquinez Straight in 1961-1962. Pages 57-62 *in*: D.W. Kelly, editor. Ecological Studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fisheries Bulletin 133.

Moffitt, J. 1941. Notes on the food of the California clapper rail. Condor 43:270-273.

Monroe, M.W. and J. Kelly 1992. State of the Estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California. 405 pp.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Trans. Am. Fish. Soc. 121:67-77.

Moyle, P.B. and R. M. Yoshiyama. 1992. Fishes, aquatic diversity management areas, and endangered species: A plan to protect California's native aquatic biota. Draft report prepared for California Policy Seminar, University of California, Berkeley, California. July 1992. 196 pp.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson. 1986. The modification of an Estuary. Science 231:567-573.

Oregon Department of Fish and Wildlife. 1994. Final Draft. Oregon conservation program for the western snowy plover (*Charadrius alexandrinus nivosus*). Portland, Oregon. 56 pp.

Page, G.W., F.C. Bidstrup, R.J. Ramer, and L.E. Stenzel. 1986. Distribution of wintering snowy plovers in California and adjacent states. Western Birds 17(4):145-170.

Page, G.W. and L.E. Stenzel, (eds.). 1981. The breeding status of the snowy plover in California. Western Birds 12(1):1-40.

Page, G.W., L.E. Stenzel, W.D. Shuford, and C.R. Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. J. Field Ornithol. 62(2):245-255.

Page, G.W., J.S. and J.C. Warriner, and P.W.C. Paton. 1995. Snowy Plover. *In* A. Poole and F. Gill, eds., The Birds of North America. American Ornithologists Union. 23pp.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. 115 - 119 pp. in J. L. Turner and D. W. Kelley, eds.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

Reeder, W.G. 1951. Stomach analysis of a group of shorebirds. Condor 53:43-45.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of U.S. Bureau of Fisheries 27(637):103-152.

Singer, M.M., D.L. Smalheer, R.S. Tjeerdema, and M. Martin. 1990. Toxicity of an oil dispersant to the early life stages of four California marine species. Environ. Toxicol. Chem. 9:1387-1395. 1990.

Sommer, T., R. Baxter and B. Herbold. In prep. The resilience of splittail in the Sacramento-San Joaquin Estuary. To be submitted to Transactions of the American Fisheries Society.

Stenzel, L.E., S.C. Peaslee, and G.W. Page. 1981. Mainland Coast. Pages 6-16 in Page, G.W. and L.E. Stenzel (eds.). The breeding status of the snowy plover in California. Western Birds 12(1):1-40.

Stern, M.A., K.A. Kristensen, and J.F. Morawski. 1988. Investigations of snowy plovers at Abert Lake, Lake Co., Oregon. Final Report for Oregon Department Fish and Wildlife Nongame Program. 12 pp.

Stern, M.A., J.S. McIver, and G.A. Rosenberg. 1990. Investigations of the western snowy plover at the Coos Bay North Spit and adjacent sites in Coos and Curry Counties, Oregon, 1990. Report to Oregon Department Fish and Wildlife Nongame Program. 33 pp.

Stevens, D. E., S. W. Miller, and B. C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. California Department of Fish and Game Candidate Species Status Report. 90-2. 149 pp.

Swanson, C. and J.J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. 77 pp.

Sweetnam, D.A. and D.E. Stevens. 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. 98 pp. plus appendices.

Test, F.H., and A.R. Test. 1942. Food of the California clapper rail. Condor 44:228.

Turner, J.L. and D.W. Kelley. 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. Fish and Game Bull. 136.

Unger, P. 1994. Quantifying salinity habitat of estuarine species. IEP Newsletter. 1994: 7-10.

U.S. Fish and Wildlife Service. 1980. California brown pelican recovery plan. Portland, Oregon. 179 pp.

U.S. Fish and Wildlife Service. 1983. California least tern recovery plan. Portland, Oregon. 56pp.

U.S. Fish and Wildlife Service. 1984. Salt marsh harvest mouse and California clapper rail recovery plan. Portland, Oregon. 141 pp.

U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; Determination of threatened status for the delta smelt. March 5, 1993. Fed. Reg. 58 (42):12854-12864.

U.S. Fish and Wildlife Service. 1994a. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. 34 pp., plus figures.

U.S. Fish and Wildlife Service. 1994b. Endangered and threatened wildlife and plants; Critical habitat determination for the delta smelt. December 19, 1994. Fed. Reg. 65256-65279.

U.S. Fish and Wildlife Service. 1994c. Technical/Agency Draft Sacramento-San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 1995. Formal consultation and conference on the effects of long-term operation of the Central Valley Project and State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail. 52 pp., plus figures and attachment.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and plants; determination of threatened status for the Sacramento splittail. February 8, 1999. Fed. Reg. (64) 5963-5981.

Varoujean, D.H. 1972. A study of the California clapper rail in Elkhorn Slough, 1972. Report to the California Dept. of Fish and Game. 9 pp.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 9.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 28.

Warriner, J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating system and reproductive success of a small population of polygamous snowy plovers. Wilson Bull. 98 (1):15-37.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. J. Theor. Bio. 48:215-229.

Widrig, R.S. 1980. Snowy plovers at Leadbetter Point. An opportunity for wildlife management? Prepared for the U.S. Fish and Wildlife Service, Willapa National Wildlife Refuge, Ilwaco, Washington. 14 pp.

Williams, L. 1929. Notes on the feeding habits and behavior of the California clapper rail. Condor 31:52-56.

Wilson, R.A. 1980. Snowy plover nesting ecology on the Oregon coast. M.S. Thesis, Oregon State Univ., Corvallis, Oregon. 41 pp.

## PERSONAL COMMUNICATIONS

Ms. Joy Albertson, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, P.O. Box 524, Newark, California 94560

Charles Bruce, Oregon Department of Fish and Wildlife, Northwest Regional Office, 7118 NE Vandenberg Avenue, Corvallis, OR 97330

Eric Cummins, Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98504

Dr. Joshua Collins, Aquatic Habitat Institute, 1301 South 46th Street, Richmond, California 94804

Mr. Jules Evens, Avocet Research Associates, P.O. Box 839, Point Reyes Station, California 94956

Ms. Elaine Harding-Smith, University of California (Santa Cruz), Santa Cruz, California

Mr. Gary Lester, 633 Third Street, Eureka, CA 95501

Ms. Lesa Meng, U.S. Environmental Protection Agency, Environmental Effects Research Laboratory, Atlantic Ecology Division/ORD, 27 Tarzwell Drive, Narragansett, RI 02882

Dr. Peter Moyle, University of California, Davis, California 95616.

Mr. Gary Page, Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970.

Dr. Howard Shellhammer, Department of Biological Sciences, San Jose State University, CA 95192

Mr. Dale Sweetnam, California Department of Fish and Game, Bay-Delta and Special Water Projects Division, 4001 N. Wilson Way, Stockton, CA 95205-2424.

Ms. Jean Takekawa, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, P.O. Box 524, Newark, California 94560

| Navigation Projects | | (depth in MLLW) |
|---|---|---|
| 1. | Sacramento Deepwater Ship Channel | –35 feet |
| 2. | Stockton Deepwater Ship Channel | –35 feet |
| 3. | Suisun Bay Channel | –35 feet |
| 4. | Suisun Slough | –8 feet |
| 5. | Napa River | –15 feet |
| 6. | Mare Island Strait | –30 feet |
| 7. | Pinole Shoal | –35 feet |
| 8. | Petaluma River | –8 feet |
| 9. | San Rafael Creek | –8 feet |
| 10. | Richmond Harbor | –38 feet |
| 11. | San Francisco Harbor | –40 feet |
| 12. | Oakland Harbor | –42 feet |
| 13. | San Leandro Marina | –8 feet |
| 14. | Redwood City Harbor | –30 feet |

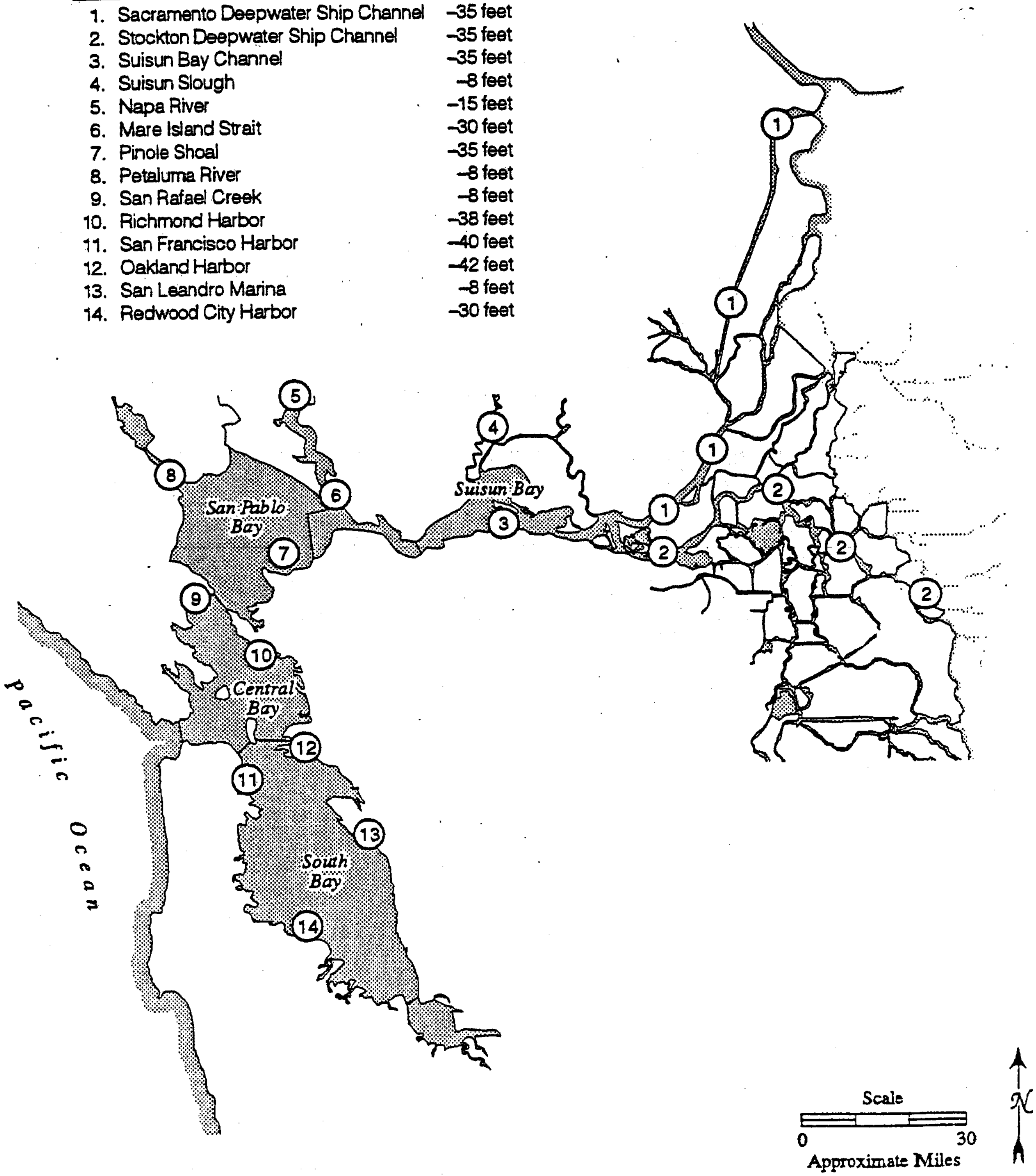



Figure 1. Army Corps of Engineers Major Navigation Projects in the San Francisco Estuary

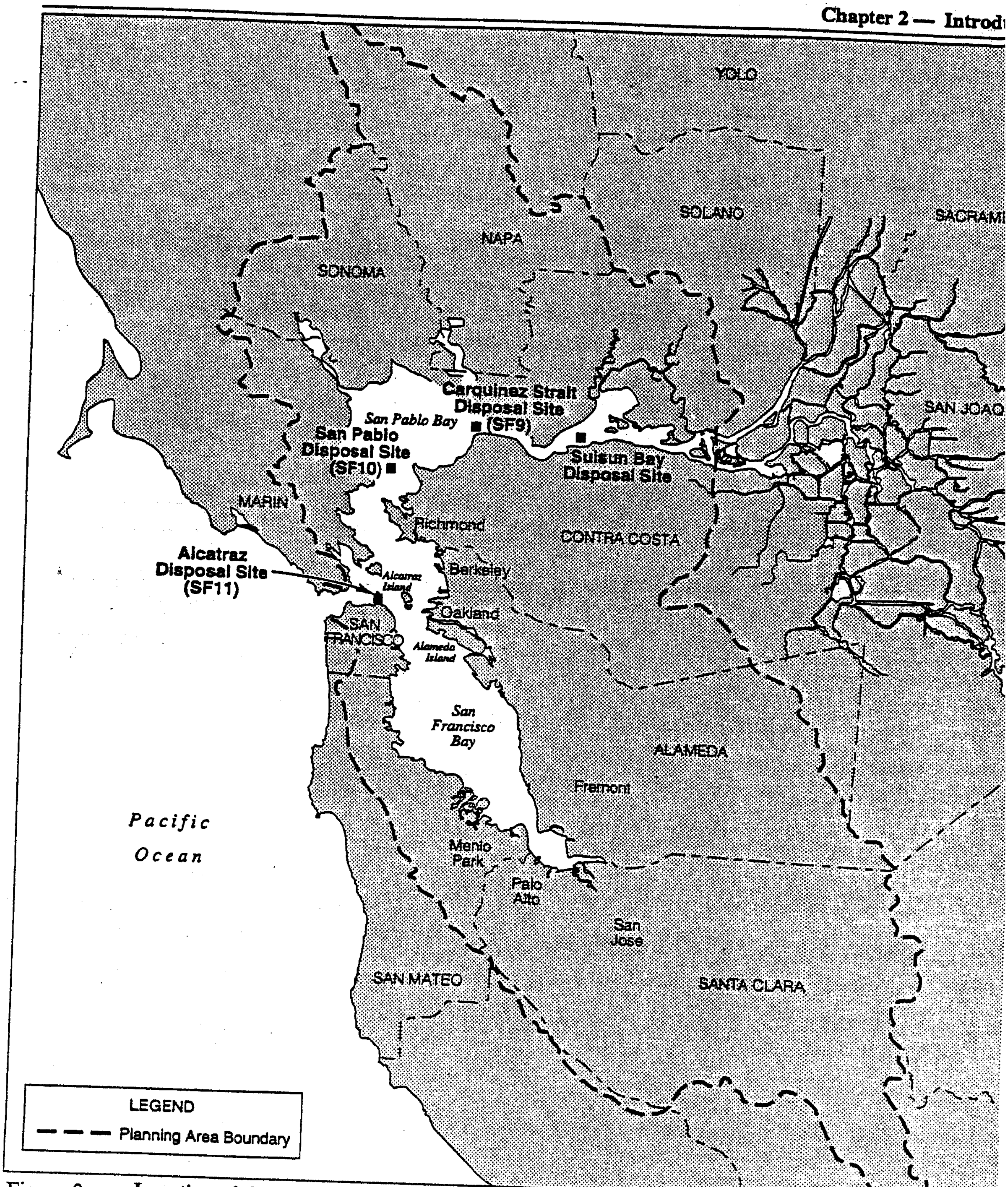



Figure 2a. **Location of the Carquinez Strait, San Pablo Bay, Suisun Bay, and Alcatraz Disposal Sites in San Francisco Bay**

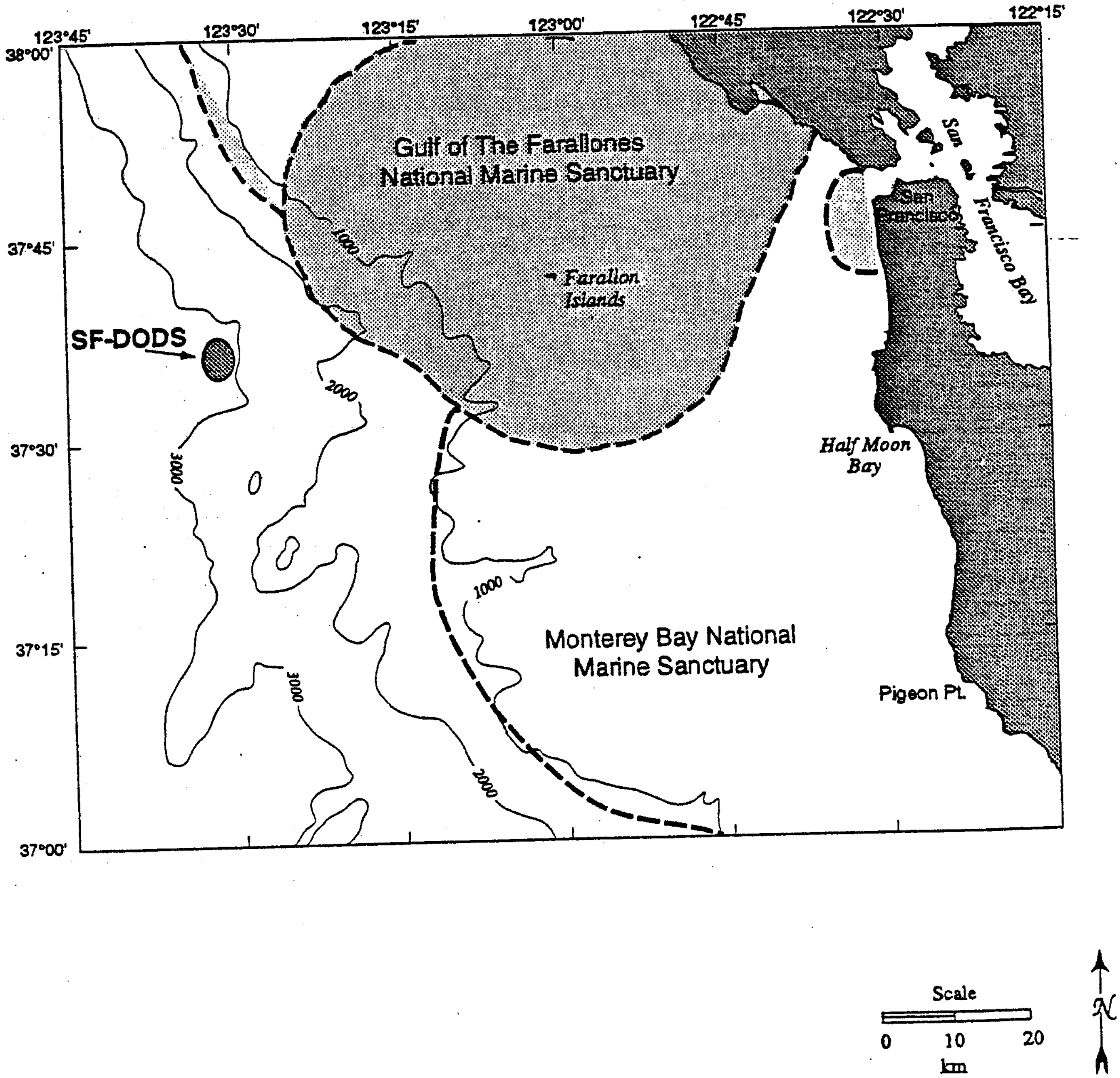



Figure 2b. Location of the San Francisco Deep Ocean Disposal Site (SF-DODS)

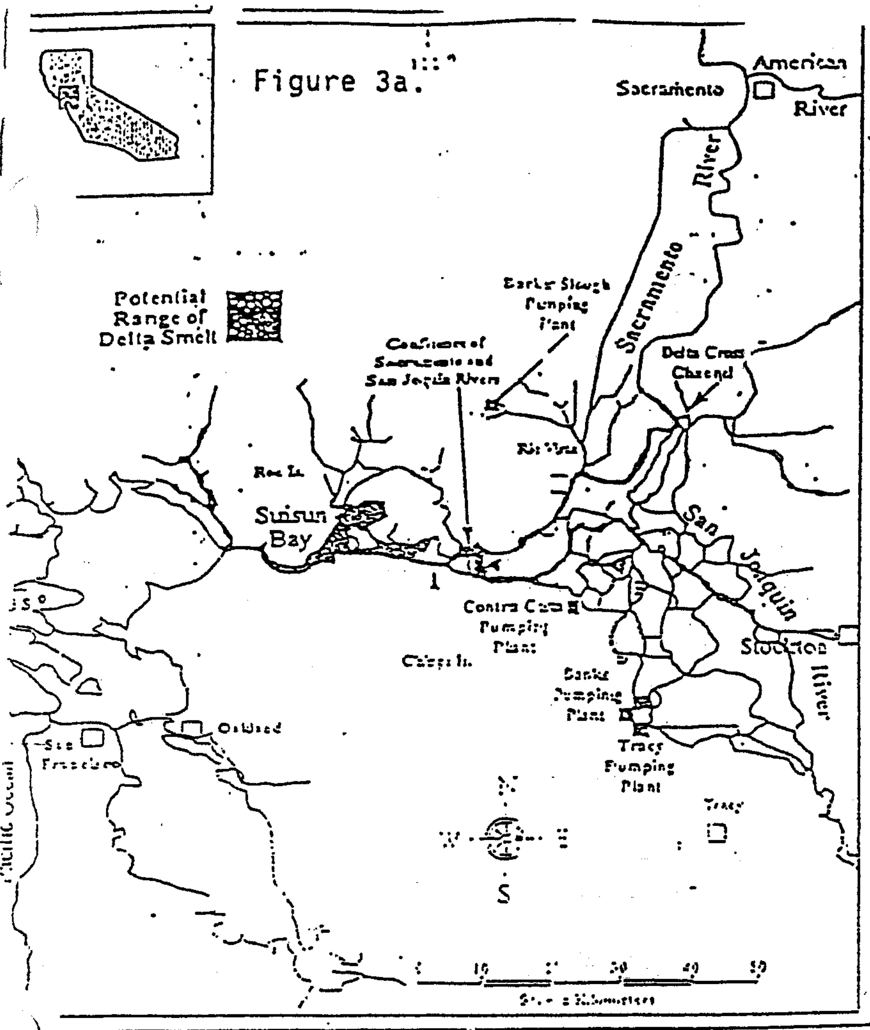



Figure 3a.

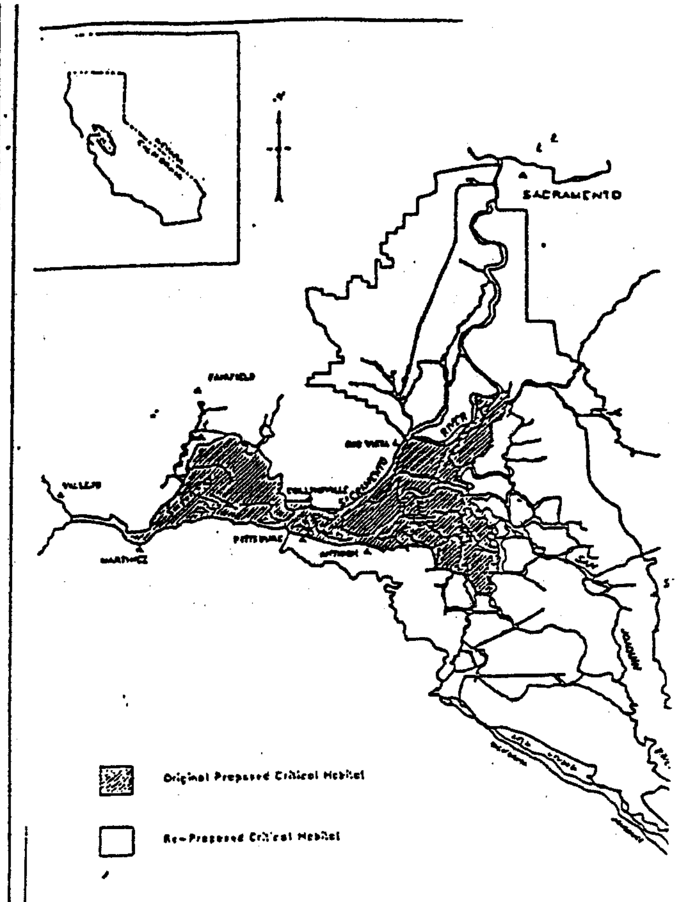
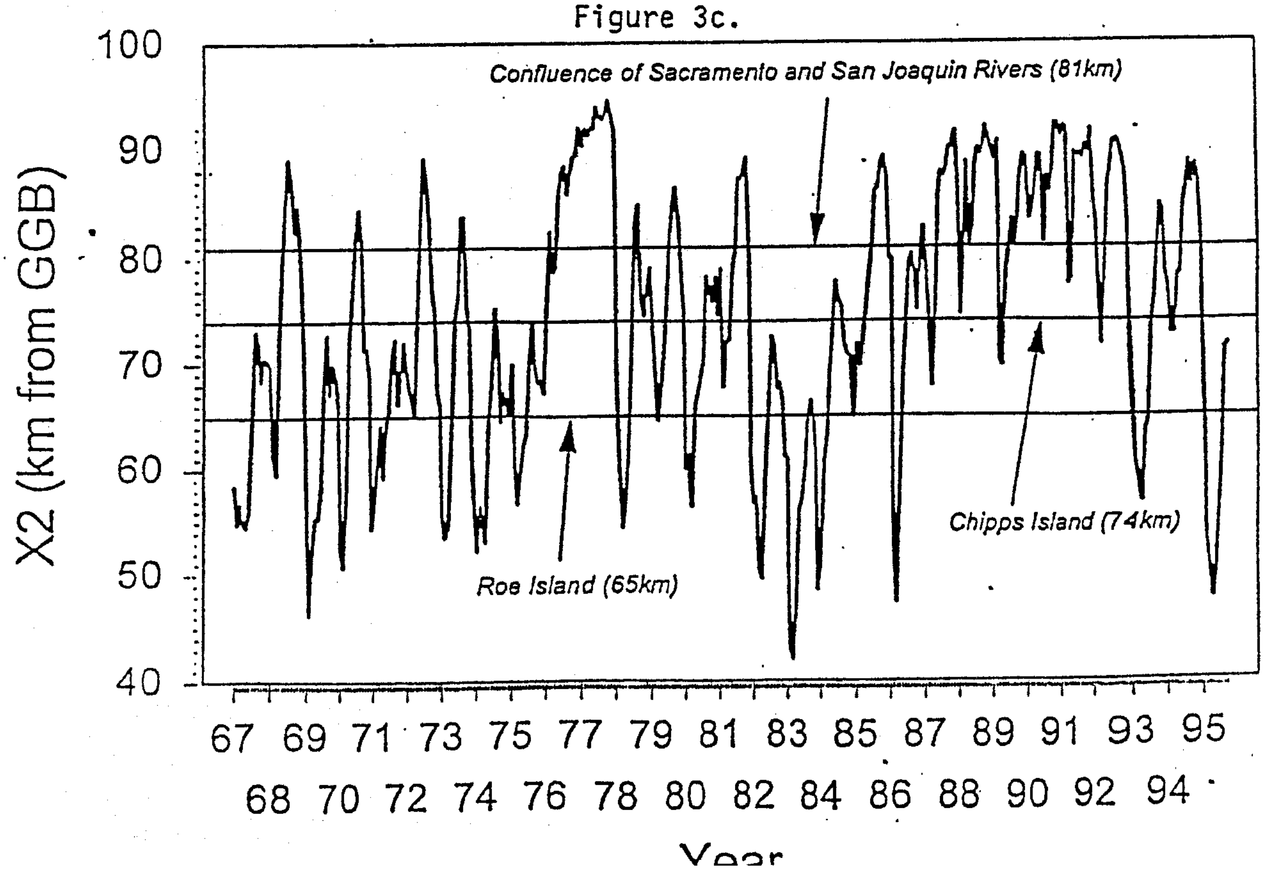
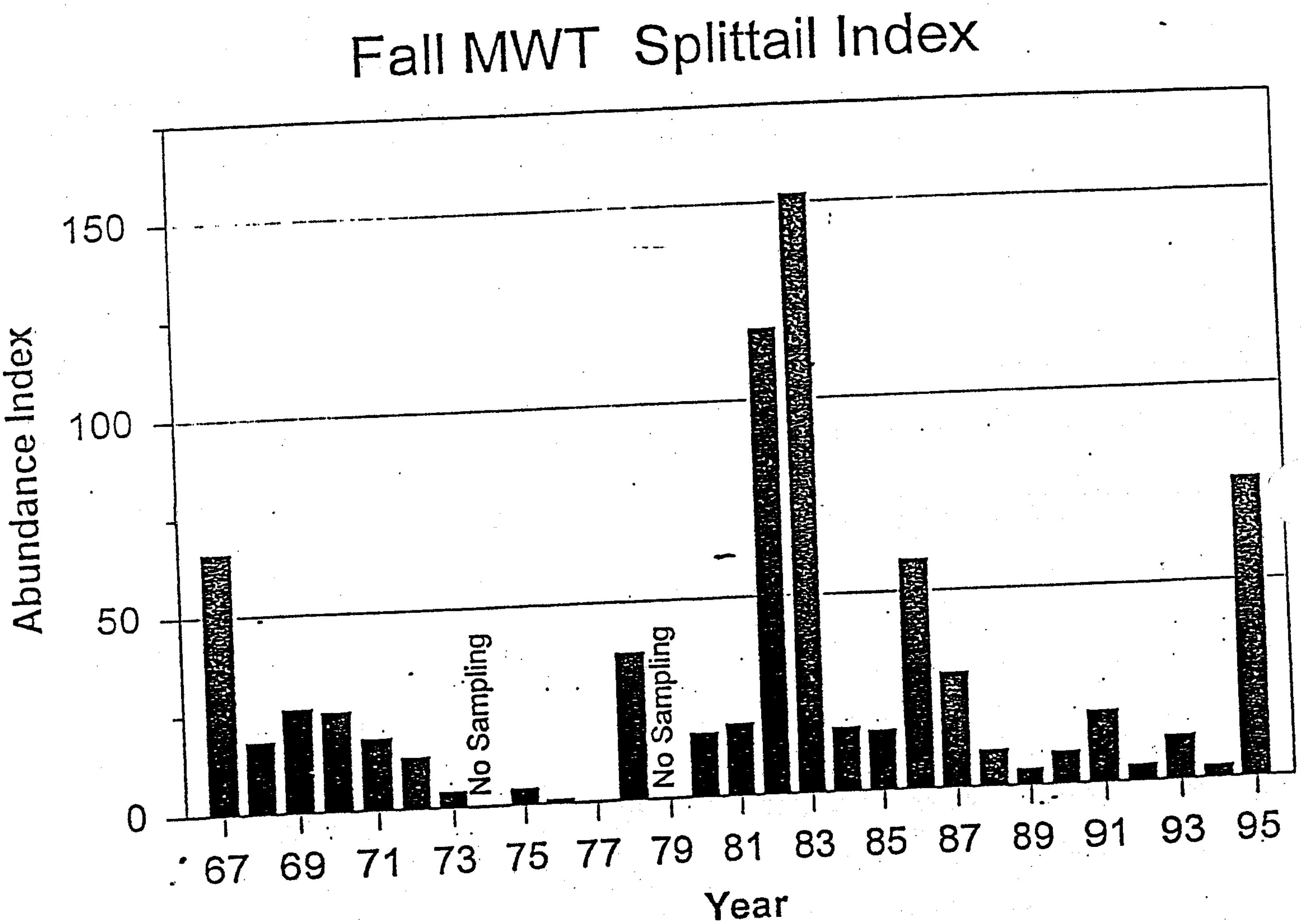



Figure 3b.

Monthly Estimates of X2 Position

Figure 3c.





Fall MWT Splittail Index
Abundance Index
150
100
50
0
No Sampling
No Sampling
67
69
71
73
75
77
79
81
83
85
87
89
91
93
95
Year


Figure 4.

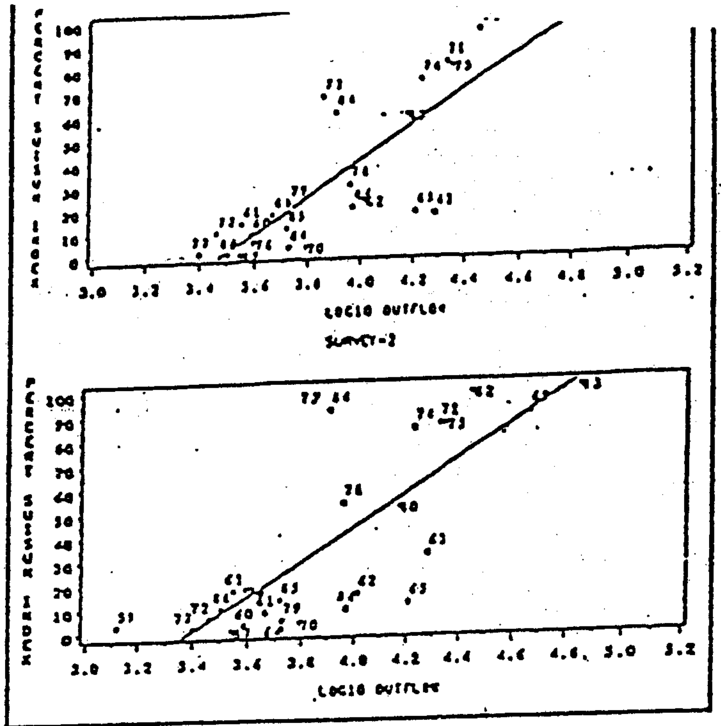


Figure 5a.

RELATIONSHIP BETWEEN THE PORTION OF DELTA SMELT POPULATION WEST OF THE DELTA AND LOG DELTA OUTFLOW DURING THE SURVEY MONTH FOR SUMMER TOW-NET SURVEY, 1959 TO 1988

For arcsine transformed percentages, $r^2 = 0.74$ for survey 1 and $r^2 = 0.55$ for survey 2.

Source: Sweetnam and Stevens 1993.

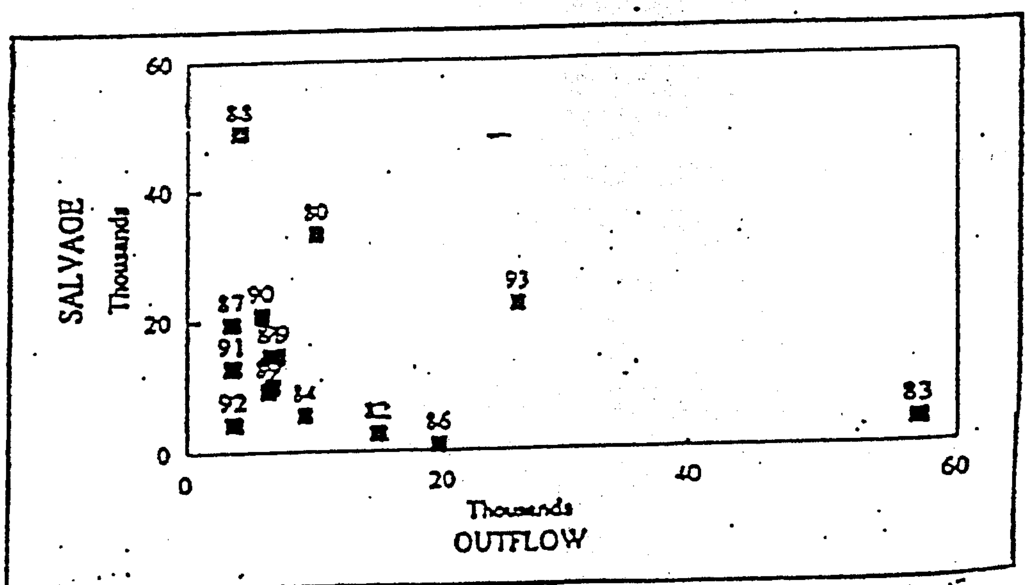



Figure 5b.

RELATIONSHIP BETWEEN EXPANDED SALVAGE OF JUVENILE DELTA SMELT AT SKINNER FISH FACILITY AND TOTAL DELTA OUTFLOW, 1979-1993

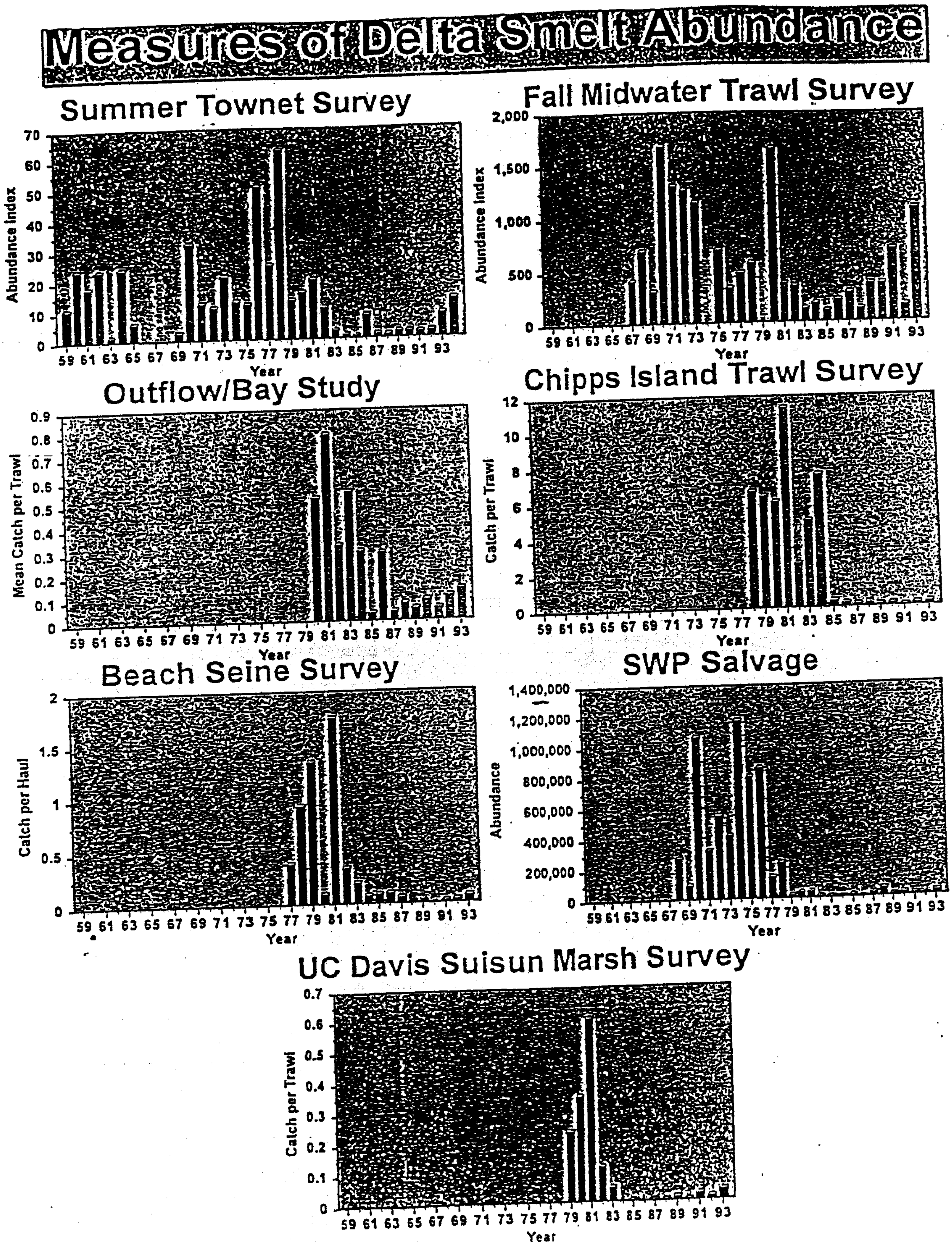

Measures of Delta Smelt Abundance
Summer Townet Survey
Abundance Index
Year
Fall Midwater Trawl Survey
Abundance Index
Year
Outflow/Bay Study
Mean Catch per Trawl
Year
Chipps Island Trawl Survey
Catch per Trawl
Year
Beach Seine Survey
Catch per Haul
Year
SWP Salvage
Abundance
Year
UC Davis Suisun Marsh Survey
Catch per Trawl
Year

Figure 6.

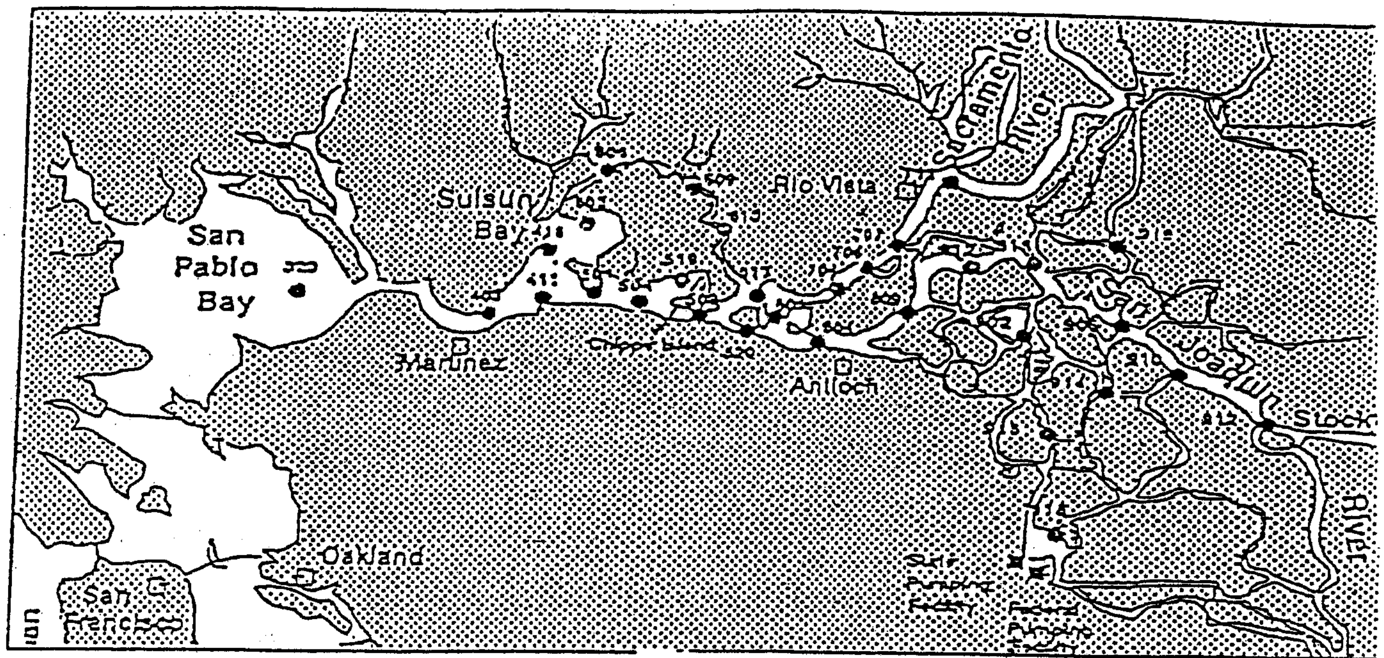



Figure 7a
SUMMER TOW-NET SURVEY SAMPLING SITES IN THE SACRAMENTO-SAN JOAQUIN ESTUARY

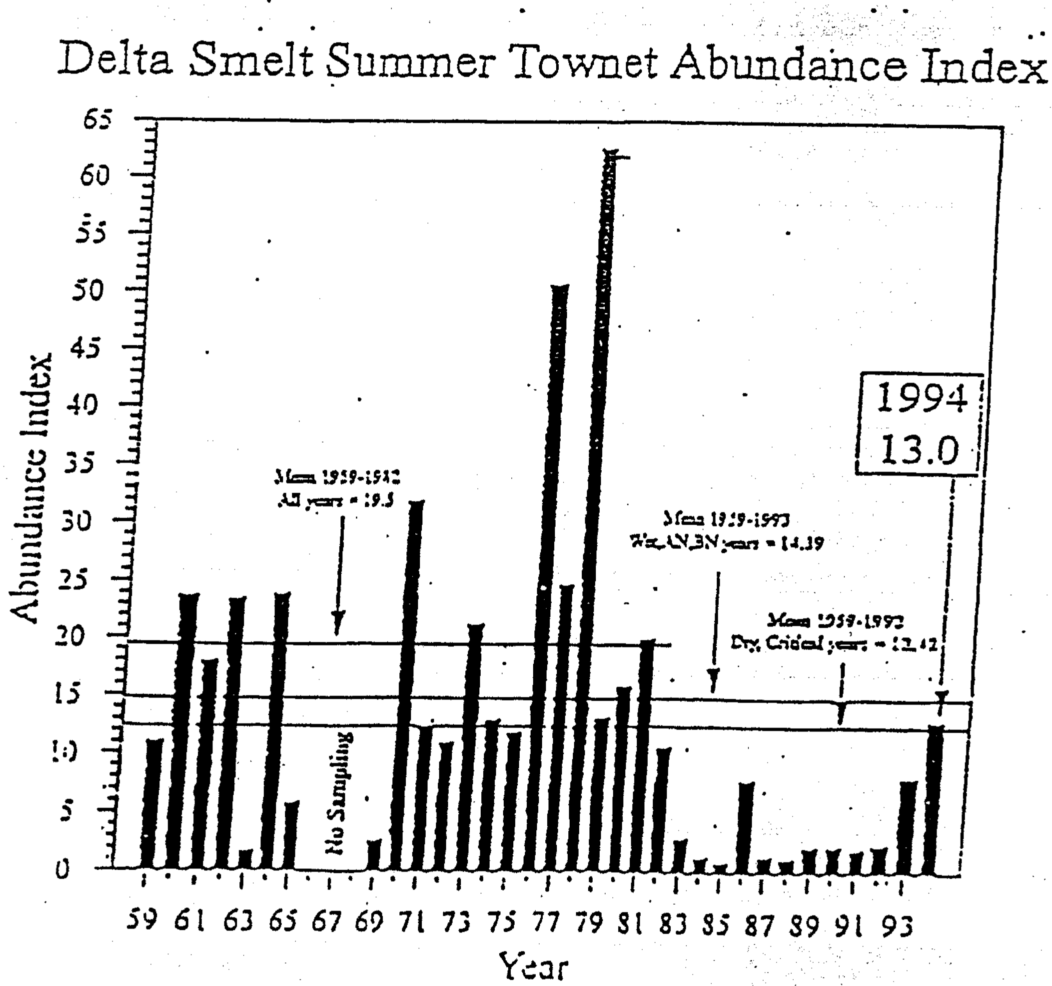



Figure 7b

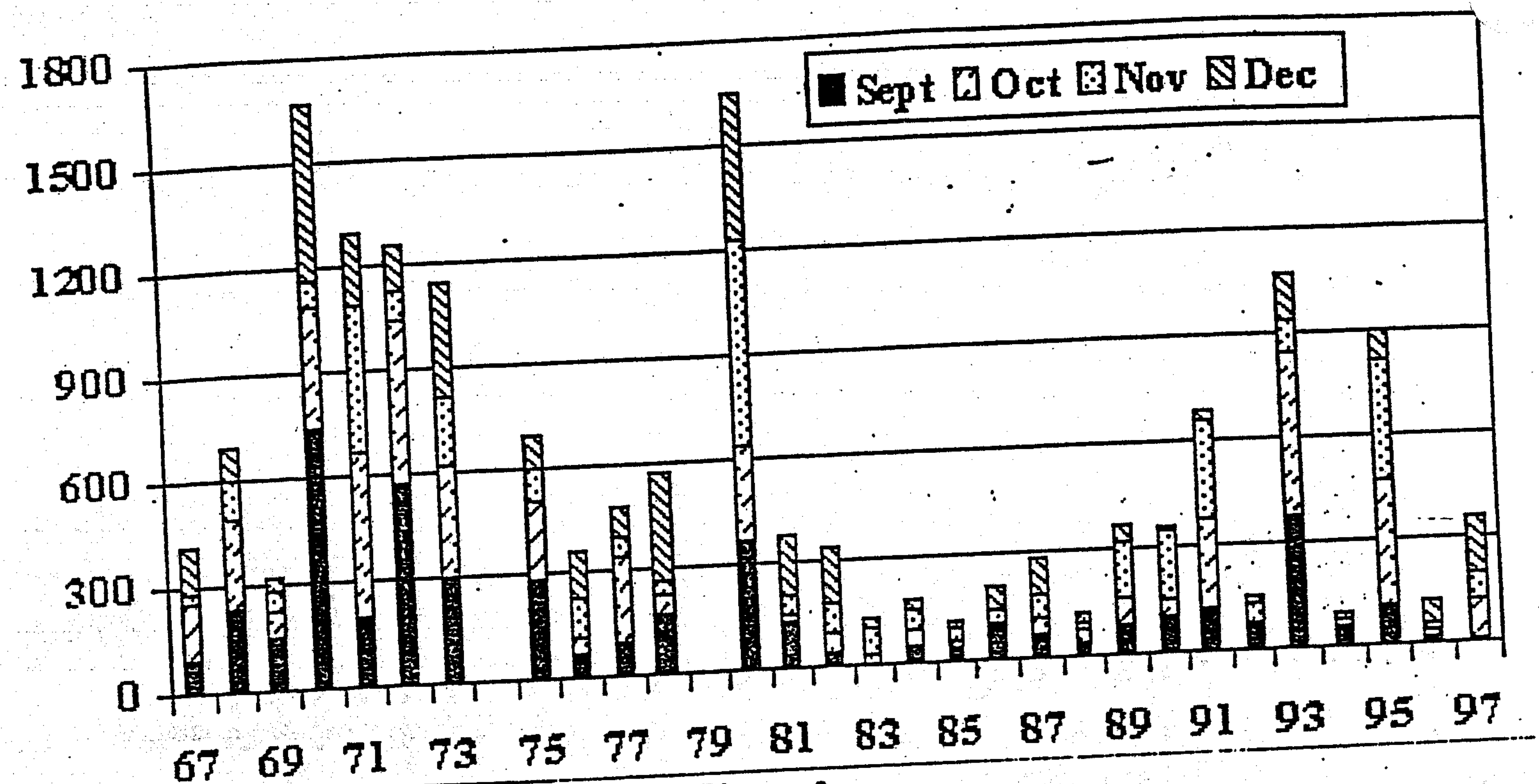
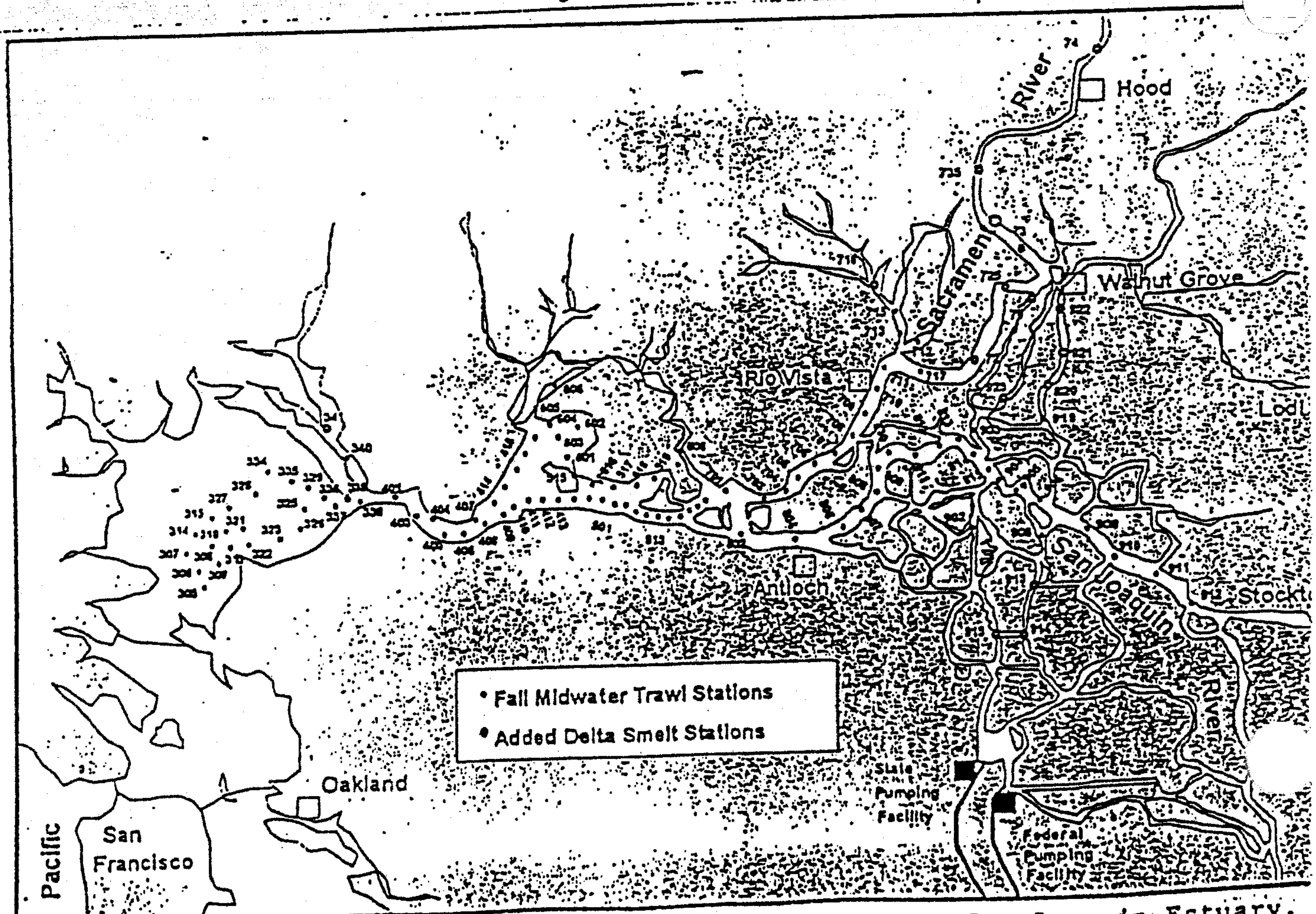



Figure 8a.




... trawl sampling sites in the Sacramento-San Joaquin Estuary.

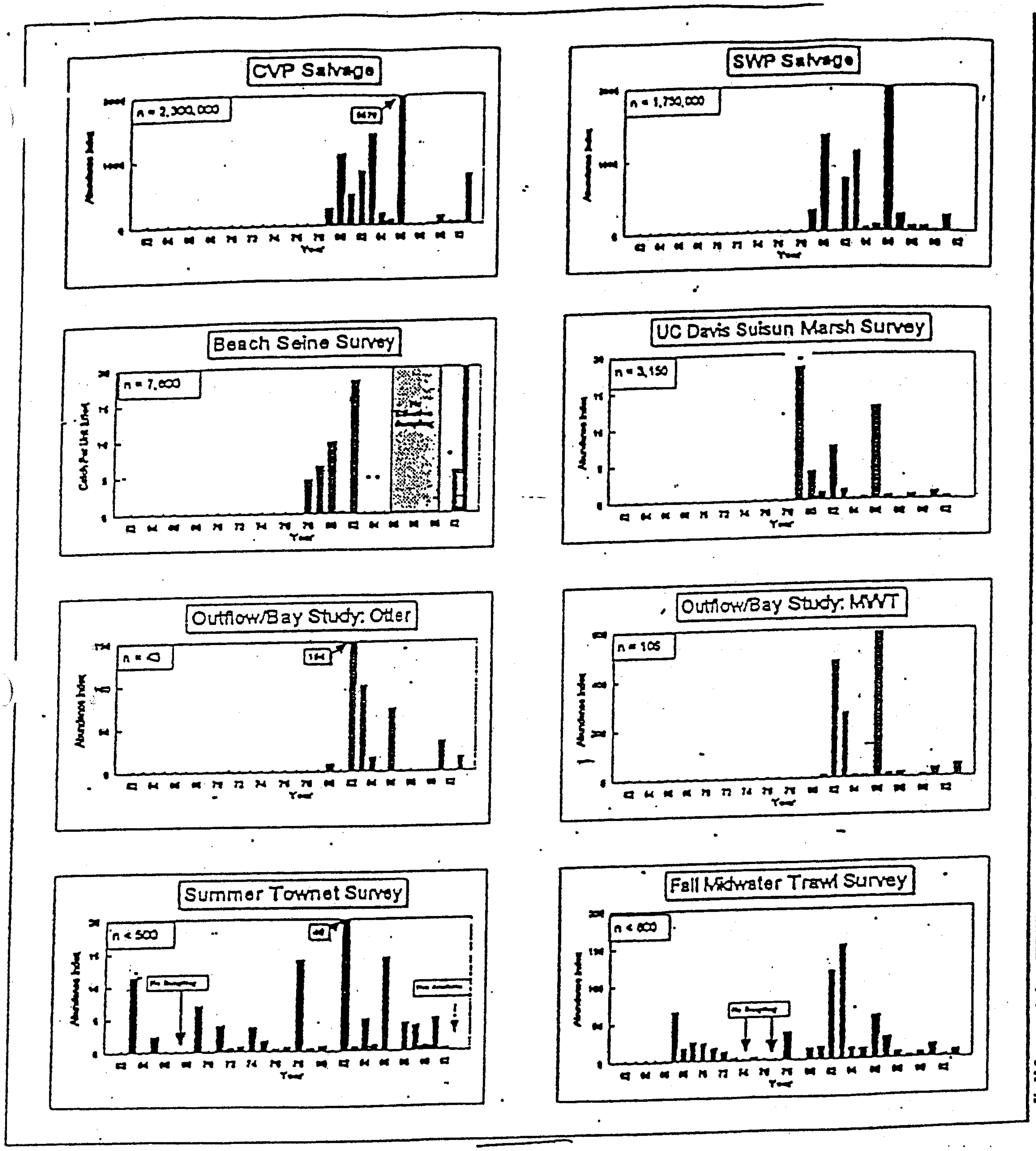



FIGURE 9 - Trends in Young-of-the-Year Splittail Abundance, as Indexed by Eight Independent Surveys